ILLUMINATING ENGINEERING

SEPTEMBER 1953

◆

Featuring

The National Technical Conference In Abstract

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

"SEE" and learn

with PITTSBURGH PERMAFLECTOR LIGHTING EQUIPMENT

The "before and after" photographs demonstrate the remarkable changes which occurred in the 24 classrooms of the Dallas Township School when they were "light modernized" with Pittsburgh Permaflector Fluorescent Units.

Good lighting makes it possible to see, teach and learn more easily and more effectively. That is why sound planning and judicious selection of the proper lighting equipment is so important.

Call in a Pittsburgh Permaflector representative in the early stages of your plans. He will recommend, without bias as to light sources, the fluorescent, incandescent or combination equipment needed to illuminate efficiently your classrooms, shops, gymnasiums, study halls and other school areas.

● **DALLAS TOWNSHIP SCHOOL**
Dallas, Pennsylvania

Elec. Engr.: C. E. Romberger
Elec. Contr.: Theodore Hinkle

THE 4-LAMP "MONROE" LUMINAIRES
Used in the Dallas Township School

Pittsburgh Permaflector "Monroe" Fluorescent Luminaires with plastic side-panels were the natural choice for classroom lighting when all factors were evaluated—initial cost, ease of installation, maintained efficiency, ease of maintenance. Only one hanger was required for every 8-foot section.

LEARN MORE ABOUT SCHOOL LIGHTING

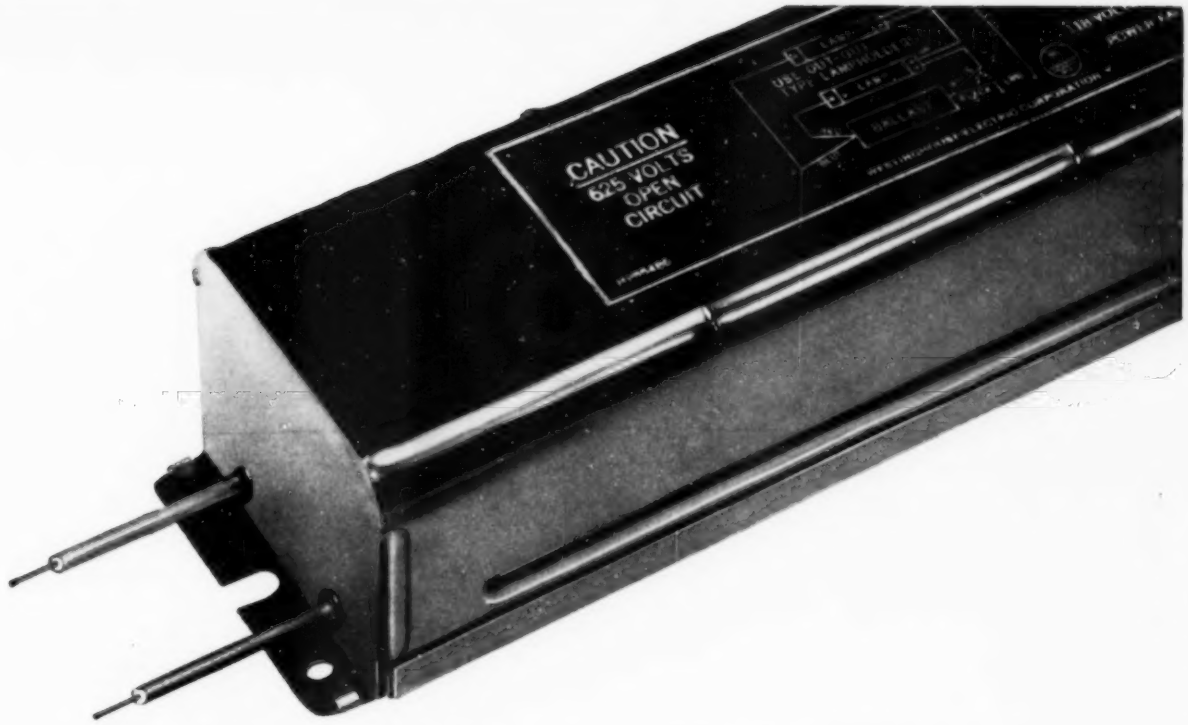
Write today for the informative Bulletin which describes the "Monroe" Fluorescent Luminaires.

PITTSBURGH REFLECTOR COMPANY

411 OLIVER BUILDING PITTSBURGH 22, PENNSYLVANIA

Permaflector Lighting Engineers in All Principal Cities

PITTSBURGH PERMAFLECTORS ARE DISTRIBUTED BY LEADING ELECTRICAL WHOLESALERS EVERYWHERE



A true, practical advance in lighting economics and efficiencies: the new Westinghouse slimline *lead-lag* ballast

. . . *the only ballast of its kind*

Once upon a time, ballast manufacturers considered *lead-lag* slimline ballasts as impractical to push because of weight, cost and size. *Westinghouse has changed all that.* New design and engineering have made weight, cost and size *comparable* to series ballasts. These new Westinghouse engineering advances, plus the manifold advantages always inherent in *lead-lag,* make its choice by users of fluorescent lighting a matter of common sense and sound economics. Here's why:

1. Independent lamp operation. You have an accurate check on lamp burnouts—no premature replacement.
2. Maximum lamp life. Tests prove up to 10% longer life than with any other type ballast.
3. Low installation cost because of simple wiring, new light weight and new small size.
4. Stroboscopic effect eliminated. Competent authorities state this effect is greatest with series ballasts . . . that dangerous "stop-go illusion" *can happen* in industrial operations under certain conditions.
5. Wattage loss now only a shade higher than series ballasts . . . to a point where cost is not a factor.

It's economical and practical to insist on new Westinghouse *lead-lag* ballasts in any fixture you buy . . . or to replace old, less efficient ballasts. The Westinghouse *lead-lag* is available for both slimline and preheat fluorescent lamps. Phone your nearest Westinghouse office for full information or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-04346

YOU CAN BE **SURE**...IF IT'S

Westinghouse

INSTALLATION: Society for Savings, Berry Square Branch, Hartford, Connecticut.
ELECTRICAL CONTRACTOR: T. J. Martin Electric Co., Hartford, Connecticut.
ARCHITECT: Sherwood Jeter in collaboration with Hartford Electric Light Co.

FIXTURES: Litecontrol No. 5924 and 5928, 2 lamp slimline recessed troffer, 4 feet and 8 feet long, using No. 9015 Holophane lens. Also No. 6FH recessed lens boxes in Reception Area, and for accent.
SPACING: 7'-0" on centers.
CEILING HEIGHT: 10' approximately.
INTENSITY: 50 Footcandles average in service, over work area.

What Makes the LIGHT Right Here?

Three things — good layout, light floor and wall coloring, and efficient lighting by LITECONTROL.

Note the interior of this bank is clean, simple, inviting. No old-fashioned glass partitions to pick up bright reflections. No clutter of desk lamps or other supplementary fixtures to cast shadows and complicate the lighting problem.

LITECONTROL recessed fixtures 5924 and 5928 blend smoothly into the ceiling. The eight-foot units assure high level illumination over the work areas. Smaller four-foot units assure adequate illumination over light-colored floors in public area.

Holophane Low Brightness Lenses throughout prevent eye-tiring glare or sharp contrasts.

Interesting high-lights in the reception room are LITECONTROL Recessed Lens Boxes.

For information on how to make your lighting installations easy on the eyes, consult your local LITECONTROL man. Or write to address below.

LITECONTROL *Fixtures*

KEEP UPKEEP DOWN

LITECONTROL CORPORATION, 36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

SEPTEMBER 1953

Vol. XLVIII

No. 9

◆

1952-1953 Officers

E. M. Strong — President

A. H. Manwaring — Vice-President

Duncan M. Jones — Vice-President

Clarence C. Keller — General Secretary

Kirk M. Reid — Treasurer

◆

Staff

Ruby Redford — Editor

Clayton E. Ellis — Advertising Manager

◆

Publications Committee

Duncan M. Jones, Chairman

J. S. Schuchert

R. M. Zabel

The President's Address	E. M. Strong	447
Progress and Growth . . . I.E.S. Goals	A. H. Manwaring	450
Abstracts from Papers, I.E.S. 1953 National Technical Conference		
Sources and Controls		453
Utilization		459
Street Lighting		464
Daylighting		471
Measurements		475
Lighting Evaluation		482
Calculating the Sound-Absorbing Effect of Acoustical Baffles in Lighting Systems	Eric H. Church	489
Some Answers to the Future of Illuminating Engineers	John O. Kraehenbuehl	495
Ventilation — the Key to Self-Maintenance	Floyd W. Sell	500
I.E.S. Lighting Data Sheet — Series XVIII Lighting a Masonic Assembly Room (16-9)		503
Questions and Answers on Light Sources		504
Also: Ceiling Rehabilitation for an Old Office, 499.		
TELECAST — Lighting News of Current Interest		5A
Lighting Calendar, 13A; Obituaries, 16A; It Seems to Me, 16A; About People, 21A; Books and Pamphlets, 46A.		
Sustaining Members		24A, 27A, 28A, 32A
New Equipment Data		42A
I.E.S. Publications		49A, 52A
Index to Advertisers		53A

◆

STATEMENTS and opinions in articles and papers in ILLUMINATING ENGINEERING are the expressions of contributors and do not necessarily represent the policies or opinions of the Society. Official Society opinions are expressed only in official committee reports specifically approved by the Council of the Illuminating Engineering Society.

Founded 1906

ILLUMINATING ENGINEERING SOCIETY

A. D. Hinckley, Executive Secretary

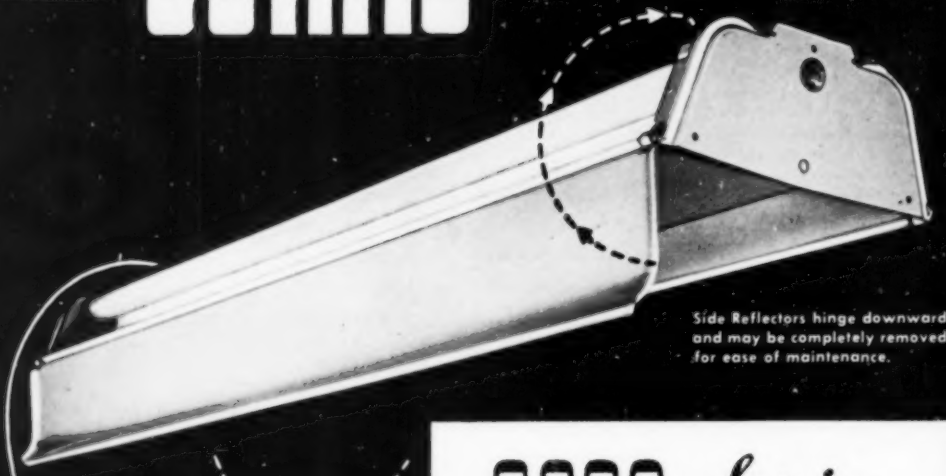
C. L. Crouch, Technical Director

PUBLICATION office 32d Street & Elm Avenue, Baltimore 11, Md.

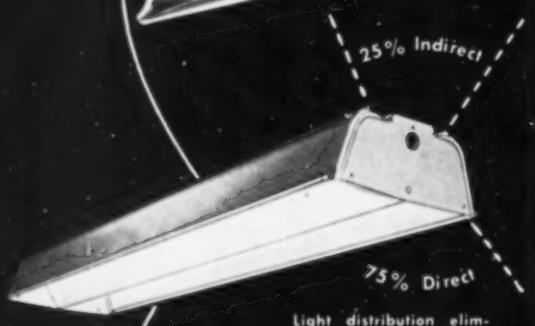
EDITORIAL and advertising offices 1860 Broadway, New York 23, N. Y.

ILLUMINATING ENGINEERING: The Journal of the Illuminating Engineering Society. Copyright 1953 by the Illuminating Engineering Society. Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R., Act of October 3, 1917. Authorized July 16, 1918. ¶ Subscription $10 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.50. ¶ Address changes must be received at I.E.S. headquarters by the first of the month to be effective with the issue of the next succeeding month.

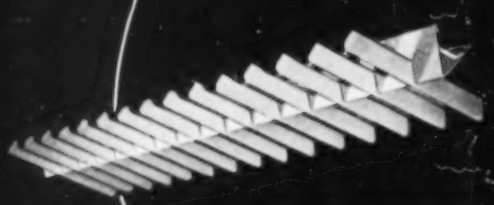
the new CURTIS *industrial*



Side Reflectors hinge downward and may be completely removed for ease of maintenance.



Light distribution eliminates severe brightness contrast and tunnel lighting conditions.



Louvers available where greater lengthwise shielding is desired.

6000 *Series*

The New Curtis "Six Thousand" series is designed for Eye-Comfort® in industrial locations. The Luminaires illuminate the ceiling with an indirect component of 25% of the light output. Crosswise shielding of 35° is provided for the 75% direct component. The lighting units in this versatile line are available with Alzak Aluminum, Porcelain Enamel, or baked white "Fluracite" enameled steel removable side reflectors. Low cost efficient maintenance is provided by having side panels readily removable for cleaning. In addition there are no horizontal diffusing or reflecting surfaces to collect dust. There is a unit in this versatile line to accommodate all 4', 5' and 8' fluorescent lamps. The Curtis "Six-Thousand" series brings Appropriate Brightness Control Lighting to industrial areas. Mail coupon for FREE descriptive literature.

Curtis "Tang Hangers*" facilitate and cut installation cost as they allow flexibility in placement of hangers and permit bypassing of building construction obstacles such as beams, sprinkler heads, etc.

*Pat. applied for.

CURTIS LIGHTING, INC.
Dept. I 41-20 6135 West 65th Street
Chicago 38, Illinois

Name_____

Company_____

Address_____

City_____ State_____

The President's Address

The 1953 Administration

EVERETT M. STRONG
President, 1952-1953

DURING each of the past two years six new chapters have been added to the Society, making the total number of Sections and Chapters now well over sixty. The addition of the new Inter-Mountain Region brings our regions up to ten. Our membership hovers this year just over and under the eight thousand mark. Our annual budget is over a quarter of a million dollars. The Society has come a long way during its forty-seven years, but always basically according to the principles set forth by its founders.

Increasing size requires change in the administrative and operating structures of the Society. No longer is it feasible for the President to visit all of the Sections and Chapters. This year I did visit about half of the Sections and Chapters, travelling from the Maritime Chapter in far eastern Canada to the Southeast Florida Chapter, and from Los Angeles to the Vancouver Island Chapter in far western Canada. Direct contact with all of these is a most stimulating and useful activity. It is gratifying to be able to report from personal observation that the Sections and Chapters of the Society are doing a magnificent job, and personal contact with so many of the local officers and members is a tremendous experience; everywhere you can depend on them to be the kind of folks you enjoy working and being with, and you feel the human strength of the Society not merely as an institution but as a living force devoted to the service of mankind through better seeing. It is one of the penalties of size that these more intimate visits of the President must be reduced to a minor activity; no longer can one man on a part time assignment visit a major fraction of our more than sixty local units without neglecting other important responsibilities during the presidential year.

It is clear that greater emphasis now devolves upon the next larger organizational unit of the Society, the Region, not only for direct presidential contact but for other activities of the Society. This year your president participated in seven of the eight regional conferences held among our ten Regions. Two Regions did not hold conferences, one being too new to initiate a conference this year, the other being the host region for the National Conference. Your president missed one of the Regional conferences because of a late shift in date after the whole itinerary had been arranged. Attendance at two others involved additional travel totalling some 4000 miles because of restrictive dates available for conference hotel accommodations. In his presidential address in 1950 President Goddard, commenting on the circumstances of his absence from one of the Regional conferences, said: "It would seem advisable that Regional Conference dates be determined possibly two years in advance so that a coordinated schedule could be continuously maintained." "They should be scheduled so that he (the President) may travel to all of them without 'back-tracking'." Three years later I am minded to resubmit this recommendation without Goddard's qualifying "possibly" two years;

Substance of an address presented before the National Technical Conference of the Illuminating Engineering Society, September 14-17, 1953, New York, N. Y.

the current long range practice of booking hotel accommodations for such conferences as ours in itself makes two-year planning a mandatory minimum, and some of the regions have already initiated such planning.

Growth of the Society and greater emphasis on regional activity and responsibility enlarges the importance and responsibilities of the Regional Vice-Presidents. Their direct contacts with the Sections and Chapters must largely replace those previously enjoyed by the President. It should be clearly understood by all concerned that the office of Regional Vice-President is not only an honorary recognition but is a major administrative job which requires the exercise of demonstrated abilities and which requires adequate time and facilities being made available for the purpose. I want to take this opportunity to pay special tribute to these men as a group, and individually according to their respective stewardships; many of them do indeed merit national recognition of highest order in the contribution they make to the services of the Society. The adequate performance of the work of a Regional Vice-President involves not only at least one annual visit per Chapter and Section in his Region but also participating in five meetings of Council, in the Regional Conference (*his* conference), in the National Technical Conference, and in meetings of the Local Activities Committee as called, usually adjacent to Council meetings.

The provision for travel facilities, unsupported by the Society budget, further restricts the availability of an already limited number of possible candidates for election to this office, and although it will require some considerable study and planning to provide the funds, I am glad to report that, on recommendation by the Advance Planning Committee, Council at its last meeting directed such study by the Finance Committee.

As a member of the President's "Cabinet" (of Council) and ambassador of the Society in his Region, there is much for the Regional Vice-President to know about the Society, its operation and policies, which requires adequate indoctrination. At present there is no established means for insuring this indoctrination until after election when it is at least a year too late, despite the recent remedial provision of a tutoring session for Regional Vice-Presidents-elect. With both this in mind and the considerable load of the Regional Vice-President's office, I have suggested to several, with favorable reaction, the creation of a Junior Regional Vice-President who would assume in office some portion of the Senior Regional Vice-President's duties and be in line to succeed the latter in due course with definite opportunity and incentive to prepare specifically for the responsibility. The details, of course, should be worked out in the appropriate committees of the Society.

We are arrived in the growth of the Society to encompass several units of student members known as Student Branches. Some of these locally are flourishing enterprises under the resident guidance of an I.E.S. member of the school staff and the sponsorship of a territorial Section or Chapter. The need is clear for more attention to these units beyond the local interests. If the Student Branch activity of the Society is to prosper on a Regional and National scale, study and planning not yet activated is immediately in order.

Consideration of students leads inevitably to two other related problems for the I.E.S.: educational activity and manpower availability. It is quite apparent that the number of college students actively interested in preparing for Illuminating Engineering in recent years is well below an already low par. This is true even if we count those engineering students who wander into the lighting field without benefit of specific preparation; the whole area of electric power, with which lighting education is commonly identified, currently lacks student interest commensurate with manpower needs. Although this is in considerable measure the reasonable consequence of accumulated neglect by the industrial interests concerned, it is further aggravated by the impact of armed forces activities which lean strongly toward electronic interests and very little toward electric power or lighting assignments of manpower. It is but natural that the student be concerned with first things first as he faces in school the near-certainty of immediate military service upon graduation, and thereby give first attention to learning about matters of benefit, possibly even to his survival, for a career of his wider choice. So long as the electronic incentive is aggravated by military emphasis, progress in restoring balance of student interest seems remote, but this does not condone apathy toward corrective measures by the industrial and commercial interests concerned.

This year our Committee on Education has initiated a two-part study addressed to clarifying the true status of a disparity between school and industry regarding the extent of demand for students prepared in Illuminating Engineering. Industry voices an unfilled need while college claims the need is not manifest within the school gates. Industry's needs are being surveyed by one subcommittee while a curriculum of studies is being built by the other sub-committee. When the two studies are ready for correlation, it should be very interesting, and we hope illuminating. I am con-

fident that our engineering colleges will provide the appropriate studies if and when convinced that they will fulfill a corresponding manpower need.

Education of the masses to distinguish good lighting from bad for different tasks, even for three-dimensional *vs* two-dimensional tasks still leaves much to be done. The key to solving this problem seems to me to reside in our homes and our public schools, in 4-H clubs, home bureaus, etc. The approach, however, must be primarily through learning fundamental principles of good lighting joined with a like approach to the color and form of interior decoration and architecture. Mere mimicry of good examples or the exploiting of fads in gadgeteering will not suffice. A hard working Residential Lighting Committee has just completed a new Recommended Practice which should help greatly to implement the home element of this basically educational need.

Heading the parade of our Society's needs, and of lighting the world over, is more knowledge of the fundamental relations between light and sight-gifted people. Because it involves human beings, their whole visually-stimulated reactions, and not only the visual mechanism, the problem is extremely complex and difficult, and begets much honest debate as to the merits and the significance of diverse research procedures and results. It is worthy of note that in the first year of the Society, 1906, Dr. Louis Bell presented a paper on "Physiological Factors in Illumination." The Society continues over the years to be interested strongly in this important phase of illuminating engineering, and slowly it seems we do uncover new fundamental truths and put them into practice.

Last June a two-day conference on Light and Vision Research was held at the University of Michigan by their Institute of Industrial Health in cooperation with the I.E.S. Research Fund. I wish time permitted review with you here of the several projects reported to the 64 attending there because some of them are going to affect your work and that of I.E.S. quite profoundly in the near future.

Our I.E.S. Research Fund, administered by a Board of Trustees and an Executive Committee was instituted in 1944 "for the purpose of research and the stimulation of research in illuminating engineering and related fields." The researches supported by the Fund are conducted by contract with Colleges and Universities following favorable appraisal by the Executive Committee and acceptance by the Board of Trustees. It is important to note that only researches of *basic* nature concern this activity; it is in no sense competitive with the developmental researches of industry or with the application studies for any specific product. We are concerned here with the fundamental knowledge about lighting and people which benefits every person and every business motivated by honorable principles.

This activity is vital not only to the effective service of the Society but to its very survival as an instrument of the high calibre instituted by its founders. I am confident that, without invoking purely philanthropic aid, the resources of the lighting business, both financially and in the wisdom of management for long range objectives are in fact adequate to support our research activity at the tempo it deserves. Council, after considered judgment and the recommendation of two committees, this year voted to combine solicitation for the Research Fund with Sustaining Membership, and I anticipate a vigorous program for next year initiating this policy. This of course neither precludes contributions directly to the Fund as previously practiced nor the ear-marking of funds for particular researches within the fundamental scope of the activity. The Society this year budgeted and paid to the Research Fund $5000 in token of its supporting interest. The Fund budget should be at least several times this amount, and $100,000 per year would not be excessive in relation to either the need or good business practice in the allocation of earnings to long range progress.

It is impossible here to acknowledge either the individual or group efforts of more than a thousand of our members who have made this Society year the productive, progressive, coordinated service that is traditional for I.E.S.; the report of the General Secretary together with the many publications and committee minutes bear testimony to our stewardship.

I do want to express my appreciation especially to the members of Council, to the chairmen of our many committees, and by no means least to our headquarters staff. This year I have encouraged the greater attendance of our executive leaders from our New York office to the Regional Conferences; it seems unquestionably a policy which should continue in the interest of effective service and the understanding that only personal contact can build.

It has been a rare privilege I shall long cherish to have this year the experience of working with so many able and enjoyable associates.

Progress and Growth . . . I. E. S. Goals

By A. H. MANWARING
President-Elect, I.E.S.

TODAY, it is with extreme humility and with heartfelt thanks for your confidence that I appear before you as President-Elect of our Illuminating Engineering Society. The friends I've made among you, the work I've watched and helped with through the years of my association here, have left with me a deep impression of the truly splendid stature of our Society.

The Illuminating Engineering Society was organized in 1906, for "the advancement and dissemination of theoretical and practical knowledge of the science and art of illumination." Our Society today has almost 8000 members throughout the world and 63 sections and chapters in North America. Its technical investigations and resulting pronouncements are carried out by voluntary technical committees covering the lighting field.

The work of our Society follows the familiar pattern of development of any new product: an idea is born, study and development follow, applications are made, commerce results.

Basic concepts originate in research. They are developed and interpreted in terms of application; application is made to lighting practice; and business results. Each step is vitally important. Neglect of one will retard growth and progress. Especially would we call your attention to the first link in the chain — research. Ideas are not born easily; travail is the price of birth! Research is many times hard, laborious and unspectacular — but the results are glorious. How the world has been inspired by new ideas, new discoveries, new inventions . . . many of them born slowly, haltingly, in temporarily unrewarding research.

Let us look for a moment at the various activities of our Society. This year we expect much from our most important Application Committees, the corps of field engineers who are studying the specific problems of industry, commerce, institutions, public buildings, transportation, communications and recreation. These committees carry on studies in almost all phases of the application of light — analyzing the tasks and isolating the objects or details that form the more difficult seeing tasks — evaluating these (using methods of the standards of quality and quantity committee) and determining the amount of illumination to be recommended. These Committees must study, too, the effects of relative diffusion and directional quality of the light to portray optimumly the details or contours. They must translate their findings in terms of currently available types of equipment to produce the effects desired. Finally, they must record their findings in suitable reports for all lighting practitioners and the public whom they serve.

An achievement of which we are all proud was the producing of the 1952 revision of our *I.E.S. Lighting Handbook* which summarizes most of the technical reports of the Society. The work of all the Society's technical committees has been focused for the past three years on this. Information in this new volume was prepared and checked by approximately 500 committee members, 31 individual authors and four other technical societies. We consider the *I.E.S. Lighting Handbook* one of the major technical efforts and accomplishments of our Society. However, progress is a continuing thing—and therefore, work will be started immediately on the new revision. Committees are now being formed to carry this forward.

Let me ask you to consider now our monthly

Substance of an address presented at the National Technical Conference of the Illuminating Engineering Society, September 14-17, 1953, New York, N. Y.

magazine, ILLUMINATING ENGINEERING. Expanded in size and frequency of publication just about four years ago, the publication has grown steadily in interest and usefulness. On the basis of reader reaction, response from advertisers and demand for reprints, the new publication program has been received with very gratifying approval. Our staff and publications committee are continuing their objective of providing a monthly publication widely representative of both the science and art of illumination, and the presentation of current good lighting practice. The publication staff is working continuously in this direction. The continued growth of ILLUMINATING ENGINEERING is one of our important goals.

Let me remind you now of the vital work being done by our I.E.S. Research Fund. The I.E.S. Research Fund, an autonomous body, was set up by the Illuminating Engineering Society in 1944, to initiate and coordinate the study of fundamental lighting problems. At the present time, fund-sponsored research is obtaining answers to questions such as:

1. How do current light sources affect the appearance of colors used in interiors?
2. How does color of light affect visibility?
3. How much illumination is required for a given visual task?
4. How effective are various types of louvers in controlling the daylight distribution across a room?
5. What is a good criterion for determining the physiological cost of seeing?

And we have two projects under way dealing with color. Dr. Harry Helson has developed an equation for predicting the color appearance for any object viewed under any illuminant for known color composition. We often set up light sources in boxes in which samples of colored materials can be examined. However, this overemphasizes color differences since the eyes in that case usually are not adapted to the illuminant in the box — and our eyes do partially adapt to light sources having different color qualities. The results of this research will make possible tables giving color changes for various light sources of commercial interest to everyone — the Architect, the Interior Decorator, the Storekeeper and the Consumer.

A Canadian study of visual performance under light sources of different color compositions has indicated no significant differences in visual acuity under four spectrally different types of white light.

A daylighting study showed vertical louvers to be more effective than horizontal ones, under certain conditions for a schoolroom.

Last, but perhaps the most important of all, is a study aimed at developing a system similar to the Weston method for determining the illumination required for any visual task. Dr. Blackwell at the University of Michigan, is evaluating the factors of size, contrast, time and accuracy as related to a comprehensive series of test objects, representing tasks found in the field. From these data, it will be possible to recommend the illumination required for the characteristics of the task found in practice.

Judge for yourselves how extremely important these projects are! So basic to progress that we plan this year to begin to institute a coordinated combination research and sustaining membership fund campaign. It will need the help of each and every member to be successful.

Early in 1952 President Strong and I attempted to establish a uniform policy as to our *administrative and technical committees* for at least a period of two years.

We are now entering the second phase of this program. Committees from last year have not been substantially changed. Whenever possible, Chairmen have been held for a minimum of two years. When this period is over the Vice-Chairman, well acquainted then with the committee's operation, moves up to assume the Chairmanship. Our technical committees follow the same pattern with at least a ten per cent turnover of new replacements. It has always been my earnest belief that any group of individuals too long in control of a committee tend to "stagnate" its effectiveness. Fortunately this situation has never existed in our Society, but as in any Society it must constantly be considered.

Yet, too few of us realize the difficulty in securing good engineering members willing to serve on our technical committees. Occasionally we criticize the use of the same old names. Gentlemen, the same old names are the "work horses" of our Society — the dependables who can be counted upon to attend the committee meetings regularly. We owe them our gratitude. But we do urgently need new active technical committee members to work with; let us say the "wheel horses" of our technical Society. Ask yourself whether you have done your part in this respect. This year it is my earnest hope we can make progress toward this goal of bringing fresh names and fresh thinking into our committees. The Regional Vice-Presidents are now making a survey of the members in our various regions who will cooperate and help on our technical committees.

Again referring to our technical committees, one major change this year is the reappointment of the "Industrial Lighting Committee." This Committee will function in a manner similar to the Aviation and Street Lighting Committees — incorporating under it such committees as, "The Lighting Study

Projects in Industry," possibly the "Lighting of Central Station Properties" and the Mine Lighting Committee.

The work of the Society is becoming easier for each incoming administration. This is made possible by our efficient administrative staff at headquarters. Dexter Hinckley as Executive Secretary does a magnificent job covering the administrative work of our Society. C. L. Crouch, our Technical Director, along with his assistants, render outstanding aid to our technical committees — the backbone of our Society. Miss Ruby Redford as our Editor and Clayton Ellis as our Advertising and Promotion Manager have each done a splendid job in building our journal into one of the most outstanding Society publications in the country. To accomplish this has required a tremendous amount of ingenuity as it has handled a middle of the road policy with the various technical committees of our Society. There has been excellent coordination between our Papers Committee, our Technical Director, our Publications Committee, our Editor and our Advertising and Promotion Manager.

This year, as incoming President of the Society, I am hoping it will be possible to have at least five reports from the Industrial Lighting Committee—sub-committee "Lighting and Study Projects in Industry." Arthur Brainerd has done tremendous work with his committee, holding meetings throughout the country in connection with the textile industry, rubber, steel, printing and many others. These reports are the down-to-earth type which can be understood by the more commercial members of our Society. These commercial engineers should put them to immediate practice. I do believe they are a most important project of the moment. Industries of various types have offered us complete cooperation, many with the aid of manpower. The printing industry report, for example, will be developed in cooperation with Printing Industries of America.

It has been a great privilege to speak to you today and I pledge myself to sincere and constant effort to administer successfully the office of the President of the Illuminating Engineering Society, with which you have honored me. I ask your support.

Index to Conference Abstract Authors

ABBOTT, W. H.: "Dimming Hot Cathode Fluorescent Lamps," page 456.

ALLPHIN, WILLARD: "Photographing Fluorescent Lighting Installations in Color," page 487.

BALDWIN, DAVID M.: "Light and Night Traffic Accidents," page 470.

BILLHARTZ, W. H.: "Functional Top-Lighting with Glass Blocks," page 471.

BINDER, A. E.: "Mercury Lamp Starting Requirements for Outdoor Applications," page 453.

BOCK, J. E.: "Effect of Temperature on Fluorescent Street Lighting Luminaires," page 465.

BOYD, R. A.: "Daylighting with a New Kind of Functional Skylight," page 472.

CAMPBELL, J. H.: "Dimming Hot Cathode Fluorescent Lamps," page 456.

EDWARDS, L. C.: "Street Lighting Photocell Control Calibration Cabinet," page 464.

EGELER, C. E.: "Maintenance of Industrial Lighting — Part II," page 462.

FINCH, D. M.: "An Instrument for the Evaluation of Night Visibility on Highways," page 475.

FRANKLIN, J. S.: "Effect of Temperature on Fluorescent Street Lighting Luminaires," page 465.

FREUND, KARL: "Design Characteristics of a Photo-Electric Brightness Meter," page 480.

GOODMAN, I. S.: "Some Applications of High Speed Motion Picture Photography to Lamp Manufacturing," page 454.

GREENE, B. F.: "Daylighting with Plastic Domes," page 473.

GUNGLE, W. CALVIN: "Electrical Characteristics of Fluorescent Lamps and Ballasts," page 455.

HASKINS, M. E., Jr.: "Efficiency and Appearance Factors in Luminous Panels," page 485.

HOLDEN, C. M.: "The Effect of Ambient Temperature on Fluorescent Lamp Performance," page 476.

HOUSER, PHILIP H.: "Some Observations on Fluorescent Street Lighting Here and Abroad," page 468.

HULTGREN, R. C.: "Cold Cathode Power Sources," page 458.

INNIS, L. E.: "Interflection Tables from Conventional Photometric Data," page 484.

JEROME, CHARLES W.: "Effect of Temperature on Electrical and Color Parameters of 40T12 Fluorescent Lamps," page 478.

JONES, J. R.: "A Comparison of Measured and Calculated Coefficients of Utilization," page 461.

KINGSBURY, H. F.: "Functional Top-Lighting with Glass Blocks," page 471.

LINDBLAD, W. N.: "Street Lighting Photocell Control Calibration Cabinet," page 464.

LOJAN, H. L.: "The Orientation Reflex," page 482.

LOSH, J. A.: "Rectangular Coordinate Photometer for Large-Area Luminaires," page 479.

MCKINLEY, R. W.: "Functional Top-Lighting with Glass Blocks," page 471.

NEIDHART, J. J.: "A Comparison of Measured and Calculated Coefficients of Utilization," page 461.

POTTER, WENTWORTH M.: "Measured Utilization Factors," page 459.

PRIMS, EDWIN M.: "The Development of Highway Lighting in Metropolitan Chicago and Northern Illinois," page 466.

REID, JOHN LYON: "Daylighting with a New Kind of Functional Skylight," page 472.

RUSSELL, ANSON H.: "Measured Utilization Factors," page 459.

SCHULTZ, H. E.: "Dimming Hot Cathode Fluorescent Lamps," page 456.

SEITZ, RICHARD J.: "The Development of Highway Lighting in Metropolitan Chicago and Northern Illinois," page 466.

SIMMONS, A. E.: "An Instrument for the Evaluation of Night Visibility on Highways," page 475.

SPENCER, DOMINA EBERLE: "A Comparative Analysis of Comfort and Glare," page 483.

VANDENBOOM, R. F.: "Maintenance of Industrial Lighting — Part II," page 462.

From the Session on

Sources and Controls

Mercury Lamp Starting Requirements For Outdoor Applications

A. E. Binder

STARTING voltages of a large number of mercury lamps have been measured over a range of ambient temperatures from 32°F down to −30°F. Lamp sizes measured were the H400-A1, H400-E1, H250-A5, and H1000-A15 types of lamps.

Voltages required for starting mercury lamps increase more rapidly at lower temperatures. For example, between −15°F and −30°F, the rate of rise of starting voltage with each drop of one degree is 8 volts for the H400-A1 and 5 volts for the H400-E1. With this rapid increase in voltage required for starting, a careful analysis of actual temperature conditions is required for the locations where mercury lamps will be employed.

Data taken from the U. S. Weather Bureau show that even in the coldest locations in the country, the temperatures at the time that mercury lamps are turned on seldom drop below −15°F. A ballast open circuit voltage which will provide satisfactory starting at −15°F is therefore sufficient for any location in this country. These voltages for the respective lamps are:

H400-A1	255 volts
H400-E1	260 volts
H250-A5	275 volts
H1000-A15	520 volts

Ballasts used indoors have lower voltages than these. These voltages are the minimum that can be used with good arc stability. They will also pro-

AUTHOR: General Electric Co., Lamp Development Laboratory, Cleveland, Ohio.

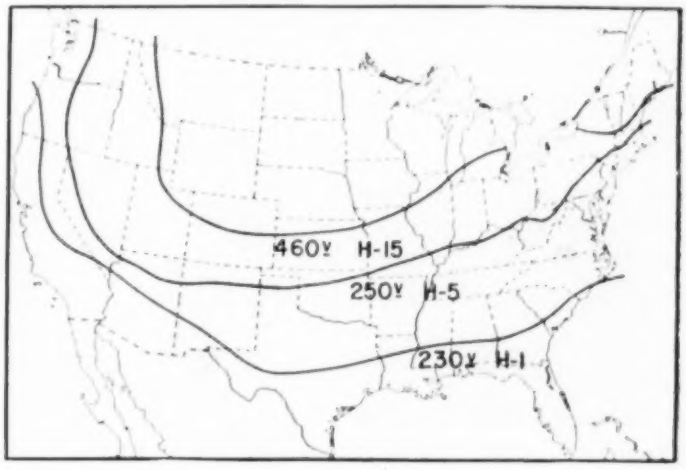


Figure 1. Voltages used for indoor ballasts may be used satisfactorily outdoors as far north as shown by respective lines. Higher voltages should be used north of these lines.

vide satisfactory starting down to a certain temperature. These voltages, and the temperatures down to which they will provide reliable starting are:

H400-A1	230 volts	13° F
H400-E1	230 volts	32° F
H250-A5	250 volts	10° F
H1000-A15	460 volts	2° F

The map shows the areas in which temperatures seldom go below these values at the time of starting. Locations south of the respective lines may satisfactorily use the lower open circuit voltage and have reliable starting. Areas north of these lines should use the higher voltages shown earlier.

In the course of measurements it was suspected that lamps started at lower voltages than those measured by conventional methods. It was determined that at −15° F, H400-E1 lamps would start at voltages as much as 35 volts less than those measured, if given a little time. This factor permitted the selection of voltages slightly lower than those which will provide instant starting under all conditions. Occasionally, when the temperature drops to its extreme low values in the coldest locations, some of the lamps may be delayed in starting at these voltages, but starting will still be satisfactory under any conditions.

(Abstract of I.E.S. 1953 Conference Paper No. 5)

Some Applications of High Speed Motion Picture Photography To Lamp Manufacturing

I. S. Goodman

RECENT developments in high speed motion picture photography have permitted taking pictures at 1000 to 10,000 frames per second. When projected back at normal speeds of 10 to 16 frames per second, actions which occur in short periods of time, often only milli-seconds, may be amplified to permit close examinations of phenomena or mechanisms involved. Some investigations applied to lamp manufacturing problems are described and illustrated. These include the initiation of the arc on long arc mercury vapor lamps, cathode-anode characteristics on short arc mercury vapor lamps, firing of various photoflash lamps, etc.

Of particular interest is the ability to analyze complex filament vibration phenomena in incandescent lamps.

Black and white and color motion pictures, shown at the Conference, suggest how this equipment and technique may be further applied.

(Abstract of I.E.S. 1953 Conference Paper No. 4)

AUTHOR: Westinghouse Electric Corp., Lamp Division, Lamp Engineering & Design, Bloomfield, N. J.

Figure 1. Half-cycle operation of E-H1 mercury lamp.

W. Calvin Gungle

Electrical Characteristics Of Fluorescent Lamps and Ballasts

THERE ARE three types of ballasts used in starting and operating fluorescent lamps. These are:

1. Ballasts in which a sufficiently high potential is provided to start the lamps with cold filaments.
2. Ballasts in which only sufficient potential is supplied to insure starting with hot filaments, coupled with an inductive voltage surge at the moment the voltage is applied to the lamp.
3. Ballasts in which a potential slightly in excess of that needed for ballasting is provided for starting, coupled with continuous heating of the filaments by separate transformer windings.

In view of the present interest in the last method of starting and operating lamps, the experimental data presented in this paper were taken with lamps and ballasts of this type. However, the conclusions are applicable to all three types.

At currents below that of desired lamp operation, the ballast must furnish an output potential in excess of that needed for operation of the lamps at those currents. This potential should decrease with increasing current such that it equals the voltage drop across the lamp or lamps at the desired operating current. That is, the point at which the lamp drop equals the ballast output voltage defines a point of stable equilibrium for the system.

The graphical representation of the current-voltage relationship of a ballast is known as a ballast load line. That for a fluorescent lamp is referred to as a characteristic curve. Typical curves are shown in Fig. 1. The load line is for a typical ballast of type 3 above; the characteristic curves are for two 40-watt lamps operating in series. All the filaments of both lamps, in the one case, were constantly heated while in the other case all but one filament were constantly heated.

As indicated by the characteristic curve with one unheated filament, a higher voltage is necessary across the lamps to draw glow currents below approximately 60 ma. This increase in potential necessary to carry the lamps over to arc operation in this case amounts to about 70 volts. It brings the lamp drop above the output voltage of the ballast as indicated by the "load line." In this case, the point of stable equilibrium for the system, represented by the intersection of the load line and characteristic curve, is at a glow current of approximately 30 ma and the lamps will be maintained in this condition by the potential barrier represented by the difference between the peak of the characteristic curve and the load line. This barrier increases as the number of unheated filaments increases.

The effect of poor emission due to improper heating can be further illustrated by a study of starting voltage as a function of resistance in a filament heating circuit. Results of a study of this type are

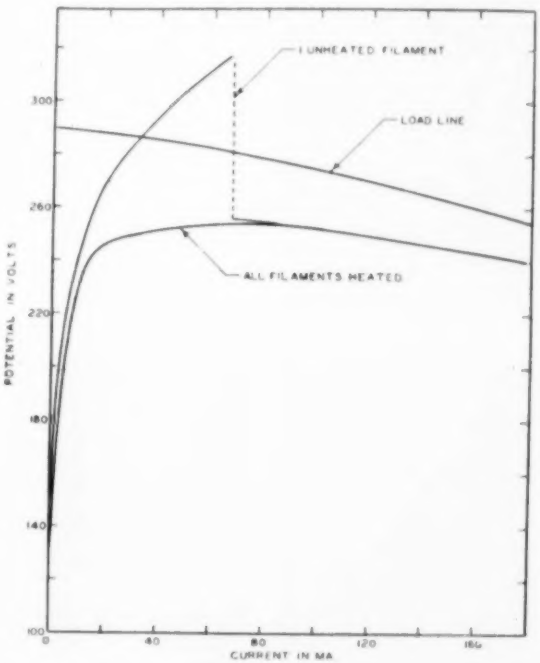


Figure 1. Effect of unheated filament on characteristic curve.

AUTHOR: Sylvania Electric Products Inc., Salem, Mass.

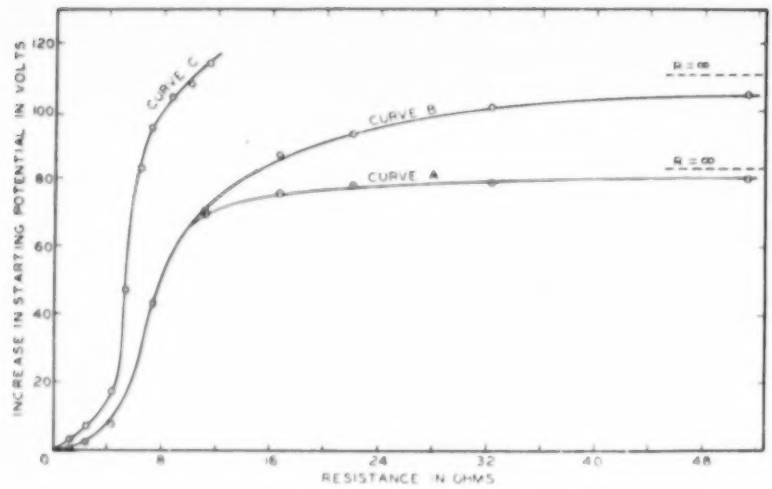


Figure 2. Effect of resistance in a filament circuit on starting.

Curve A. Lamp No. 1

Curve B. Lamp No. 2

Curve C. One filament each of Lamp No. 1 and Lamp No. 2

given in Fig. 2. As shown by these curves any resistence in the filament heating circuits, such as poor contact between lamp pins and holder contacts, will introduce difficulties in starting.

In conclusion, the electrical characteristic curve of a fluorescent lamp, or lamps, is a guidepost for the design of a ballast to be used therewith. Such curves are also useful in analyzing difficulties which may be encountered and can help to establish the limits of adverse conditions which can be tolerated.

(Abstract of I.E.S. 1953 Conference Paper No. 2)

J. H. Campbell

H. E. Schultz

W. H. Abbott

Dimming Hot Cathode Fluorescent Lamps

IT HAS long been the desire on the part of lighting engineers to find a method for controlling the brightness of fluorescent lamps over a wide range. Filament lamps can be varied in brightness by reducing or increasing line voltage. The amount of light emitted, being directly related to the temperature of the filament. However, due to the complex characteristics of electric discharge lamps and associated auxiliary equipment only a narrow range of brightness change is practical with line voltage control.

Method of Operation.—The new method of dimming controls the interval of current conduction during each half cycle of the 60-cycle voltage. This is accomplished in the control unit by connecting two thyratrons back to back so that the pair of tubes will conduct current for both polarities of the

AUTHORS: J. H. Campbell and H. E. Schultz are with the Application Engineering Department, Lamp Division, General Electric Co., Cleveland, Ohio; W. H. Abbott is with the Specialty Transformer and Ballast Department, General Electric Co., Fort Wayne, Indiana.

a-c voltage. The tubes operate together as a synchronous switch which closes the circuit at a predetermined point in the a-c voltage each half cycle and opens at the end of each half cycle. Fig. 1a shows the voltage wave applied to the entire lamp load when the interval of conduction is set for 90 degrees or half of each cycle.

The ballast for each lamp contains a choke coil to limit lamp current and a preheat transformer to keep lamp electrodes hot. This insures good lamp life and provides for reliable starting at any point in the dimming range. Across the lamp is a small capacitor which suppresses radio interference and resonates the sharp voltage rise at the leading edge of the applied voltage to start and re-ignite the lamp on each cycle. The oscillogram in Fig. 1b illustrates this voltage condition.

Characteristics of the Dimming System.—The dimming system is presently designed for 40-watt Rapid Start lamps. The cathodes in this lamp can be continuously heated with low current supplied by a relatively small ballast. Lamp brightness is controlled smoothly to a level of 1 per cent of normal.

Fluorescent lamps on dimming circuits offer several advantages over filament lamps: higher efficiency over the dimming range, lower operating cost and better color control. Filament lamps become increasingly red as they are dimmed; fluorescent lamps change very little in color over the entire brightness range. Fig. 2 shows the efficiency relationship of a 40-watt warm white fluorescent lamp and a 200-watt filament lamp for a wide range of dimming.

Dimming Control.—The fluorescent lamp dimming control has three parts each of which may be located remote from the other two. The ballast and lamp make up one part, the dimming control unit is the second part and the intensity control is the third part. Two models of the control unit are available. One will control thirty-five (or less) 40-watt Rapid Start lamps and the other eight (or less). The distribution circuit is shown in Fig. 3.

Applications.—The greatest demand for dimming fluorescent lamps has come from the theatre and stage lighting field. However, many others can now make use of the advantages of fluorescent lamps with controlled light output. Television studios, auditoriums, restaurants, night clubs, hotels, display areas, show windows and experimental laboratories are included in the list of lighting fields for which this system is expected to serve a useful purpose.

(Abstract of I.E.S. 1953 Conference Paper No. 1)

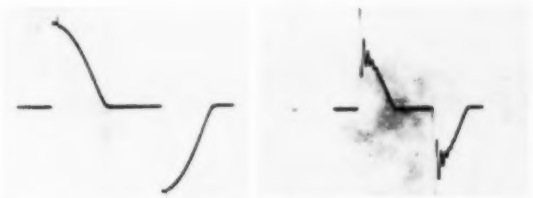


Figure 1a. (left) Operating voltage applied to the lamp circuit for the 90° conduction point.

Figure 1b. (right) Open circuit voltage applied to the lamp for the same point as Fig. 1a. The high peak voltage is a result of the steep rise on the voltage of Fig. 1a, applied to the L-C combination in the ballast. This peak insures starting and re-ignition on each cycle.

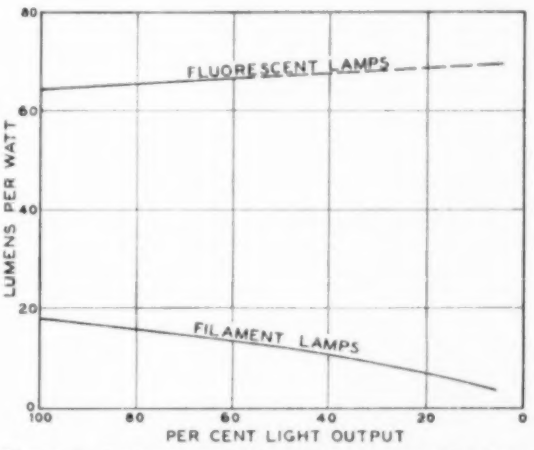


Figure 2. Comparison of lamp efficiency for the fluorescent and incandescent lamps over the dimming range for white light.

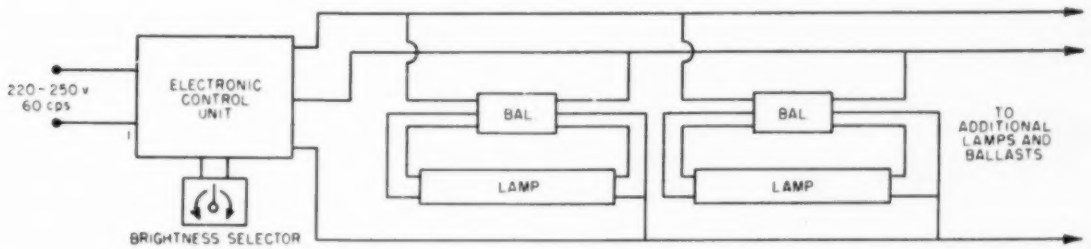


Figure 3. Block diagram of dimming system for fluorescent lamps. The control unit may be placed anywhere and two wires run to the Brightness Selector and only three wires to the lamp load.

Cold Cathode Power Sources

R. C. Hultgren

IN DESIGNING a power source for cold cathode lamps, two important lamp characteristics must be considered:

(1) The lamps have a negative resistance characteristic.

(2) The lamps rise in voltage during life.

To care for the first condition, inductance, capacitance, resistance or a combination of the three must be used in series with the lamps. It has been found by testing lamps on lag-lead ballasts, that the lead or capacitative circuit maintained its light output with age, but in the lag, or inductive circuit, the current and light output dropped as the lamp voltage increased.

AUTHOR: CELing Inc., St. Charles, Ill.

A cold cathode lamp will not operate efficiently on a purely capacitative circuit, due to the poor wave form obtained. Using a combination of inductance and capacitance, the wave form will be much improved and the lumen output will hold up as the lamp voltage increases.

Several ballasts have been designed and tested using a combination of inductance and capacitance. The most satisfactory has been found to be a 4-lamp, series mid-point cutout type ballast. Fig. 1 illustrates the circuit diagram for this ballast. The current wave form through the lamps and the electrical characteristics of this ballast are shown in Figs. 2 and 3 respectively.

This ballast provides a much improved wave form, thereby affording increased ballast and lamp efficiencies. The overall efficiency, including ballast losses is 47 lumens per watt. Another important advantage of this ballast is that either Type LP or Type HP cold cathode lamps can be used.

(Abstract of I.E.S. 1953 Conference Paper No. 3)

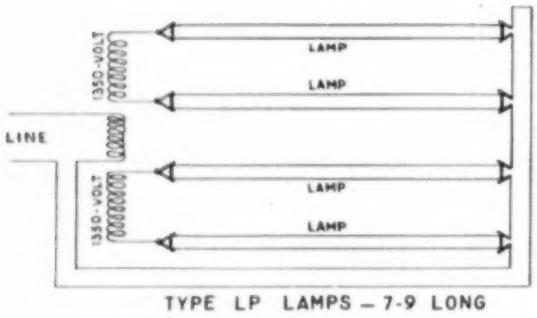
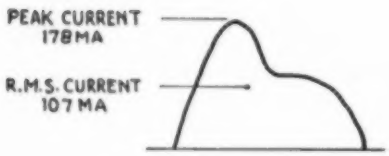


Figure 1. (left) Four-lamp series mid-point cut-out type ballast.

Figure 2. (below left) Current wave form through the lamps with this ballast.

Figure 3. (below) Test on one ballast. (See Fig. 1.)



LAMP NOS.	LAMP CURRENT	LAMP WATTS	TOTAL LIGHT	TOTAL PRI. WATTS	PRI. CURRENT
1	108 MA	39.3 W	8800 LUMENS	186 WATTS	1.67 AMPERES
2	107 MA	38.8 W			
3	109 MA	38.7 W			
4	108 MA	38.9 W			

LINE-118 V—OPEN CKT VOLTS-SEE FIG. 5-BALLAST LOSS-30.3 W
OVERALL L.P.W. = 47

From the Session on

Utilization

Measured Utilization Factors

Wentworth M. Potter

Anson H. Russell

UTILIZATION factors for various candlepower distributions and a wide variety of room conditions have been determined by the authors. For this purpose, the flexible laboratory facilities and instrumentation previously described in ILLUMINATING ENGINEERING (page 619, December 1951) were employed; luminaire arrangement, room proportions and reflectance patterns were readily varied. The actual luminaires used were carefully photometered for distribution and total output. The factors obtained are compared with empirical and calculated values from other sources.

Among the direct components tested were: a wide distribution of roughly cosine form (filament RLM Dome unit), a bat-wing curve often desired for industrial lighting (R-52 reflector lamp), and several concentrated distributions.

Fig. 1 shows an example which deals with the wide direct distribution. This falls in the Harrison-Anderson "Medium" classification and is within the range of their original tests. The new measured factors are lower in tall narrow rooms such as ratios 0.6 (J) and 0.8 (I) where Harrison and Anderson used one centrally-located unit. In the larger rooms with high reflectances, better cosine

AUTHORS: Application Engineering Department, Lamp Division, General Electric Co., Cleveland, Ohio.

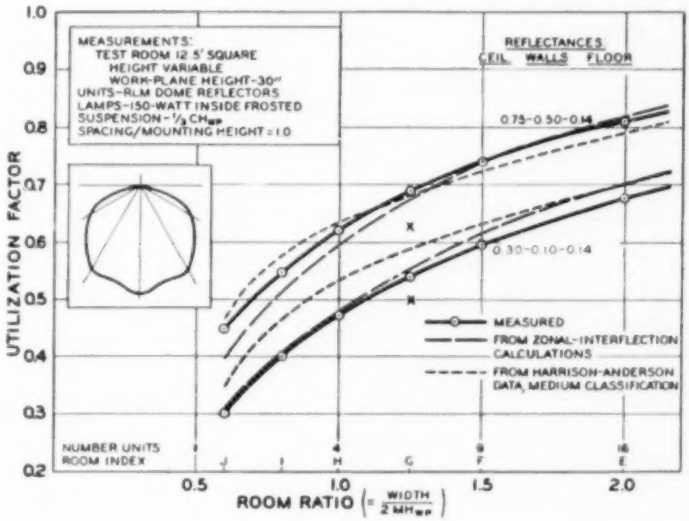


Figure 1. Test data are compared with values derived from published data at two reflectance combinations. Comparisons are made on the same basis of fixture suspension, and on a 1.0 spacing-to-mounting height ratio, except that Harrison-Anderson data do not specify numbers of units. A 0.4 spacing-to-mounting height ratio displays the same relationship between test and calculated data, but the actual values are lower. Utilization factors for the two reflectance combinations as calculated from Moon and Spencer's data for a cosine distribution are indicated by X for a room 10 feet high with $k_r = 0.8$.

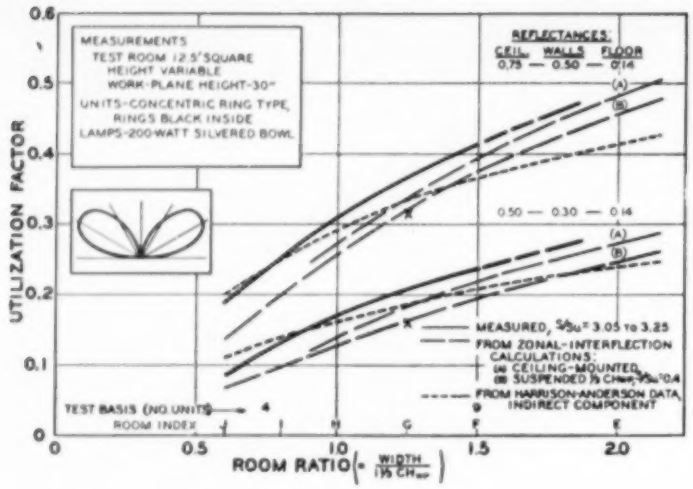


Figure 2. Measured utilization factors for two combinations of reflectance, for spacing-to-suspension ratio of 3.05 to 3.25 are given in the solid curves. Other curves are derived from two sets of published utilization data. Note that they are based on other conditions as to suspension and number of units. Utilization factors for the two reflectance combinations as calculated from Moon and Spencer data for an indirect cosine distribution are indicated by X for a room 10 feet high with k, equal to 0.8. The calculated utilization factors do not include an allowance for obstruction of the ceiling.

correction makes the new factors somewhat higher than the old. Utilization factors obtained by calculation are also shown.

Measured and calculated factors differed more with the medium (bat-wing) distribution than with other direct units tested, with measured values higher in all cases. Wall brightness above the work-plane, varying in tests but assumed uniform in calculations, may contribute to such differences.

In the case of narrow distributions, measured and calculated utilization factors are in excellent agreement. In larger rooms particularly they are generally higher than factors for the "Focusing" classification, as extrapolated from Harrison-Anderson utilization data.

For ready comparison of performance of different direct distributions, flux ratio is a simple index of flux distribution with respect to utilization. The present flux ratio (0°-40° Lumens/0°-90° Lumens) is applicable over a wider range than is now used; further extrapolation could have given closer results for very narrow distributions. Another type of flux ratio may provide an even greater range of usefulness.

A wide upward distribution, typical of a silvered-bowl lamp unit with no candlepower at 90 degrees, was also investigated for a variety of room conditions. Fixture suspension and spacing were selected on the basis of practicability, appearance, and distribution of ceiling brightness. Utilization factors based on measurements are tabulated for a wide range of room reflectances in the complete paper. A selection of measured values is compared with empirical and calculated data in Fig. 2. Despite a small amount of ceiling obstruction from fixtures and light concentrated on the wall far above the work-plane, measured values are substantially higher than calculated. Variation in ceiling brightness, no greater than 3 to 1 in test rooms, may contribute to this difference. Light from elements of ceiling area which are more centrally located is better utilized than that from peripheral elements. Therefore, higher measured utilization factors result than with a uniformly bright ceiling reflecting the same total lumens.

Other extrapolations with indirect units included measurements of the effect of placing a white strip at the top of walls of 0.50 reflectance. Gains in utilization up to 10 per cent were realized.

To assure exact comparisons, measured test results were compared with utilization factors calculated especially for the same room and lighting conditions. Some highlights of the findings are as follows:

Direct, Wide Distribution: Calculated factors agree well with measured factors; differences are within four per cent.

Direct, Medium (bat-wing) Distribution: Measured utilization factors exceed calculated factors by from three to nine per cent for room ratios 2.0 (E) to 0.6 (J).

Direct, Narrow Distributions: In general, measured and calculated factors agree within three per cent. Maximum difference was 6.6 per cent.

Indirect (wide bat-wing) Distribution: Measured utilization factors exceed calculated factors by six to sixteen per cent of the former in lower ratio rooms with high values of reflectance for ceiling and walls.

(Abstract of I.E.S. 1953 Conference Paper No. 11)

A Comparison of Measured and Calculated Coefficients of Utilization

J. R. Jones

John J. Neidhart

THE PROBABLE accuracy of calculated coefficients of utilization has been the subject of considerable discussion and controversy in the past few years. This led the authors to the introduction of the Zonal Method or Zonal-Factor Interflectance Method, but it remained necessary to prove the merits of this new method with actual test data.

Accordingly, a test room was constructed wherein the average illumination level provided by typical installations of representative luminaires could be measured. By means of adjustable walls and ceilings it is possible to vary the proportions of the room from a Room Ratio of 0.6 (J index) to 3.0 (C index). The ceiling of the room was painted flat white with a 75 per cent reflectance. Walls and floor are neutral gray with a 50 per cent reflectance for the walls and 14 per cent reflectance for the floor.

All test units were operated on a stable, constant voltage power supply. Luminaire locations were symmetrically spaced in accordance with good lighting practice and the assumptions upon which both the Harrison-Anderson Three-Curve Method and the Zonal Method were based.

AUTHORS: Westinghouse Electric Corp., Bloomfield, Lamp Division and Cleveland Lighting Division, respectively.

Three typical photometric distributions — indirect, general diffuse, and direct — were selected as being representative of the complete range of luminaire distributions. A 200-watt silvered bowl lamp mounted in a simple lampholder was used for the indirect luminaire, and a 200-watt inside frosted, general service lamp in the same lampholder was used for the general diffuse luminaire. To obtain the data for direct lighting the general service lamps were installed in RLM deep bowl reflectors.

Measurements were made with each of the three types of luminaires suspended from the ceiling a distance equal to $\frac{1}{3}$ the ceiling height above the work plane. This suspension length corresponds with the length assumed in the current I.E.S. Room Ratio formula and Room Index table. Since shorter lengths are now used in practice, test data were also obtained with suspensions equal to $\frac{1}{5}$ the ceiling height above the work plane. Further data

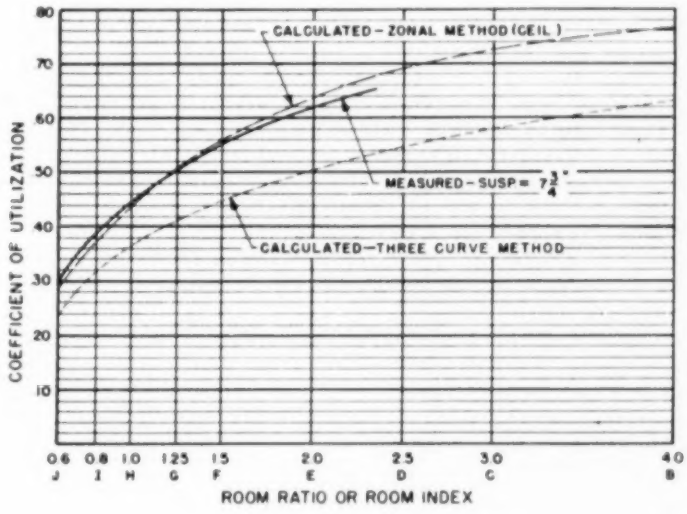


Figure 1. Measured and calculated coefficients of utilization for bare general service lamps are plotted against room ratio. The lamps were ceiling mounted when the test measurements were made.

were obtained for general diffuse and direct luminaires mounted as close to the ceiling as practicable to check the accuracy of Zonal Method coefficients based on ceiling mounting.

All comparison data are shown by means of curves such as Fig. 1, in which the coefficients obtained by illumination measurements in the test room are compared with coefficients calculated by both the Zonal Method and the Three-Curve Method. In general, Three-Curve coefficients are usually lower than Zonal coefficients but even the Zonal coefficients are often slightly conservative. The comparison indicates that greater accuracy can be obtained by calculating coefficients by the Zonal Method than by the Three-Curve Method.

(Abstract of I.E.S. 1953 Conference Paper No. 13)

Maintenance of Industrial Lighting — Part II

C. E. Egeler

R. F. Vanden Boom

THE FIELD tests on the light output depreciation due to dirt of industrial luminaires, inaugurated by the authors in early 1951, were extended to cover a period of over two years. These data make possible the calculation of actual maintenance factors as well as the effect of cleaning frequency on the overall cost of light.

AUTHORS: Application Engineering Department, Lamp Division, General Electric Company, Nela Park, Cleveland, Ohio.

For the low-bay production areas, the depreciations due to luminaire dirt ranged from 15 per cent (of initial) in a laboratory area, to 38 per cent in the core room. In the high-bay areas involving different manufacturing operations for the two-year period, the illumination values dropped 28 per cent in the heavy machine shop, and 55 per cent in the foundry. In most shop areas, the dirt on the reflectors produced greater depreciation than did dirt on the lamps.

By integrating the depreciation curves of Figs. 1 and 2 to a given month which will represent the intervals between cleanings, the per cent mean output of each luminaire can be determined. The calculated maintenance factors are shown for five different cleaning intervals per year, as well as for no cleaning. They vary from .83 for the laboratory and storage area, cleaned 6 times per year, to as

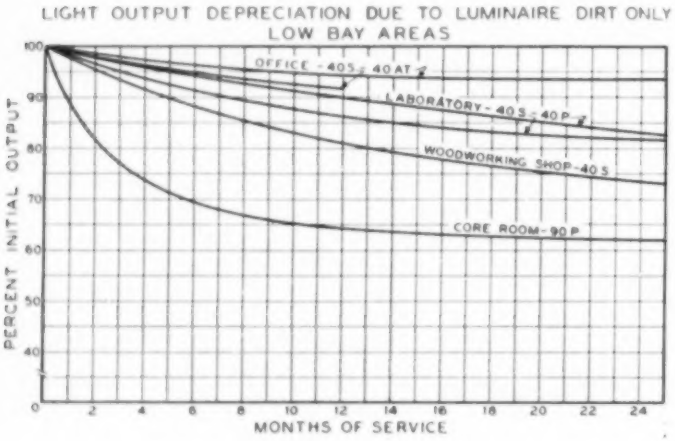


Figure 1. Effect of luminaire dirt in low-bay areas.

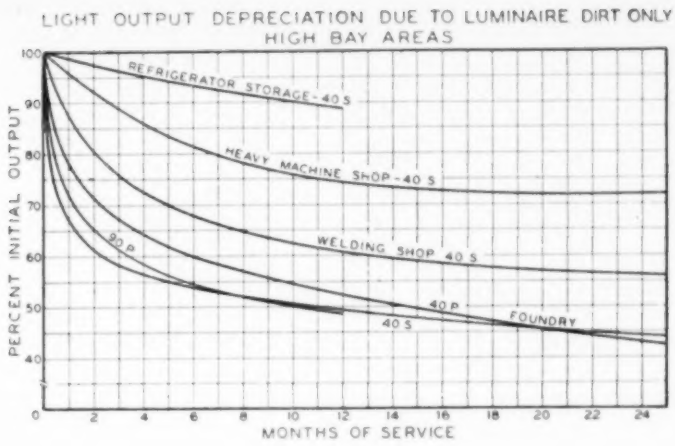


Figure 2. Depreciation in light output in high-bay areas.

low as .32 for the foundry assuming no cleaning. Although the number of cleanings per year determines to a large extent the maintenance factor to be used, a comparison of the maintenance factors may well determine which proposed cleaning schedule plant management should adopt. In one area, for example, to obtain the same average footcandles without cleaning, inspection of the maintenance factors reveals that 40 per cent additional luminaires would have to be installed.

Since the practical design objective is to produce maintained footcandles at the lower possible cost with a given type of equipment, maintenance plays an important part in the overall cost of lighting. The table gives a comparison of overall cost of light for various cleaning frequencies in the areas tested. No one cleaning schedule is the most economical for all areas. In most of the areas tested, either two or three cleanings per year produce the greatest economies. The maximum economic cleaning costs which would be economical for two cleanings per year per luminaire, are shown for the several types of work areas and lighting units.

The possibility that a correlation might exist between luminaire dirt and reflectance depreciation of small test plates, was investigated for the heavy machine shop area. The data indicate that the depreciation of a test plate inclined about 80 degrees above the horizontal, corresponds closely to the luminaire depreciation for the same area. However, further tests are needed to establish a correlation in other types of areas.

(Abstract of I.E.S. 1953 Conference Paper No. 15. Just prior to press-time this paper was transferred to the session on Evaluation.)

Economics of Cleaning.

1. Area	2. Luminaire Type[1] and Finish	3. Annual Burning Hours	4. Annual Operating Cost/Luminaire (Without Cleaning)[2]	5. Annual Owning & Operating Cost Per Luminaire Without Cleaning[3]	6. Cost Per Luminaire Cleaning	7. Relative Overall Cost of Light — % Cleanings Per Year						8. Economic Cleaning Cost (Maximum) Per Luminaire for 2 Cleanings Per Year
						0[4]	1	2	3	4	6	
Low Bay (8' to 12' Mounting Height)												
Office	1 - 40W Aluminum	2000	$ 1.77	$ 7.27	$ .50	100	104	108	114	120	132	$ .19
Office	2 - 40W Synthetic	2000	3.54	8.17	"	100	97	100	105	110	120	.45
Laboratory	" "	6200	11.00	15.62	"	100	92	91	92	94	99	1.39
Laboratory	2 - 40W Porcelain	6200	11.00	15.79	"	100	90	91	92	94	99	1.36
Woodworking Shop	2 - 40W Synthetic	3000	5.30	9.93	"	100	86	85	88	91	97	1.23
Core Room	2 - 90W Porcelain	4600	18.02	26.19	.80	100	87	83	81	81	82	3.65
High Bay (20' to 50' Mounting Height)												
Refrigerator Storage	2 - 40W Synthetic	8700	$15.43	$20.06	$ .80	100	91	92	94	97	103	$1.72
Heavy Machine Shop	" "	2300	4.08	8.71	"	100	95	95	99	104	117	1.00
Welding Shop	" "	4000	7.10	11.73	"	100	84	81	82	84	89	2.37
Foundry	" "	3600	6.38	11.01	"	100	85	83	85	86	92	2.08
Foundry	2 - 40W Porcelain	3600	6.38	11.18	"	100	72	71	70	72	77	3.42
Foundry	2 - 90W Porcelain	3600	14.12	21.92	1.35	100	74	79	70	71	74	6.50

[1]All luminaires of the closed-top industrial type except for single lamp aluminum troffers used in office.
[2]Operating cost includes lamp cost at 30% discount, labor cost of 50c per lamp replacement and electrical energy at 1½c per kwhr.
[3]Owning cost includes luminaire, installation and wiring costs amortized at 15% per year.
[4]Estimated — assumes depreciation at 25-month point is representative of mean depreciation with no cleaning.

From the Session on

Street Lighting

Street Lighting Photocell Control Calibration Cabinet

W. N. Lindblad

L. C. Edwards

THE DEVICE described in this paper was designed for the calibration of photo-controls at a 1.5-footcandle switch-on value in the field by non-technical personnel. It is not greatly different from some cabinets and light tunnels in present use; however, it incorporates some features that simplify both construction and operation.

The cabinet consists of a wooden cubicle, two feet on a side, illuminated on the interior at 1.5 footcandles by projecting light through an aperture in one side. The control to be calibrated is subjected to this illumination at an adjacent aperture on the same side. The unit therefore is exposed to the reflected light from five other interior surfaces with none directly from the source. This form was accepted as most nearly approaching the photometric sphere in the simplest practical form. Holders are provided for three different types of controls; they are complete with glass covers or housings and maintain the phototubes at a given position in the illumination aperture. Screw driver adjustment holes are provided in order that an adjustment of the unit's potentiometer can be accomplished with the control intact.

The method of operation is to expose a control to the 1.5-footcandle illumination and simultaneously adjust the potentiometer until a switch-on operation is obtained. This operation is indicated by the lighting of a small lamp simulating a controlled street light. Subsequently an off operation is obtained by means of a burst of the bright light. The 1.5 footcandle illumination level can be altered to either 15 per cent higher or lower, 1.7 and 1.3 footcandles respectively. These two values are helpful tolerances when calibrating. For example, when a control is adjusted to switch "on" at 1.5 footcandles it should not go "on" at 1.7, and if a supposedly calibrated unit fails to switch "on" at 1.5 footcandles it is considered satisfactory if it goes "on" at the lower value of 1.3 footcandles.

AUTHORS: Engineering Laboratory, Pacific Gas and Electric Co., San Francisco, Calif.

There is no provision for adjusting the "off" value; however, it was found to have an average value of 3.5 footcandles.

The interior illumination is provided by a 10-watt, blue daylight lamp. The potential supplied to the lamp is maintained at a constant value by means of a constant voltage transformer. The initial setting of 1.5 footcandles is obtained by adjusting the lamp in the aperture and measuring the interior illumination with a footcandle meter.

Measurements indicate that the twilight and dawn curves of illumination are similar when one is plotted as the mirror image of the other. The operating value of 1.5 footcandles is at the knee of the curve where the rate of change is approximately 0.35 footcandle per minute. In the morning, because of the shape of the curve, the time beyond the 1.5-footcandle value to attain the switch-off value of 3.5 footcandles is approximately four minutes. This accounts for a yearly overburning of 1460 minutes. This value is 0.6 per cent of the scheduled yearly 4100 hours. This time checks with burning time measurements made by means of elapsed time meters on several typical installations.

(Abstract of I.E.S. 1953 Conference Paper No. 20)

Effect of Temperature on Fluorescent Street Lighting Luminaires

J. E. Bock

J. S. Franklin

FLUORESCENT lamps and luminaires are unique among present-day light sources, in their sensitivity to the ambient temperature. Filament lamps with their extremely high temperatures; mercury arc lamps with an outer jacket enclosing the inner jacket; and the vacuum flasks around sodium lamps, protect these lamps from wide fluctuations in light output as the ambient temperature varies. At the present time, fluorescent lamps are not so fortunate, so for outdoor applications it was imperative that information be available on the variation in light output with ambient temperature.

There are many factors, other than temperature, that affect the light output, and to one degree or another they have been studied. The temperature characteristic, because of its pronounced effect, has received our greatest attention to date. This paper presents a proposed method which would enable anyone to predict changes in light output with ambient temperature from fluorescent street lighting luminaires. Information regarding the test set-up (Fig. 1) and technique employed is given as a guide to others interested in this kind of testing.

Weather. — A glance at the weather map issued by the United States Weather Bureau shows that temperature is a function of location and time. For our particular application and study, we selected an operating range from −20 F to 90 F range.

Most of the data in this paper have been taken in the presence of a 2 mph wind.

Effect of Temperature on Light Output. — Previous papers have shown that the light output of fluorescent lamps is dependent upon the bulb wall temperatures; that, in turn, is dependent primarily on the type of lamp, its current, and surrounding ambient temperature. Assuming one type of lamp and current, it is obvious that the surrounding ambient temperature can be greatly affected by the type of enclosing luminaire within which the lamp or lamps operate.

After several tests in a variable temperature room, it was noted that the relative light output (in per cent of the maximum) of various luminaire-lamp combinations was plotted against bulb wall temperature the points followed a definite pattern and could be expressed in a curve as shown in Fig. 2. It also indicated that maximum light output

AUTHORS: General Electric Co., Lighting and Rectifier Dept., Lynn, Mass.

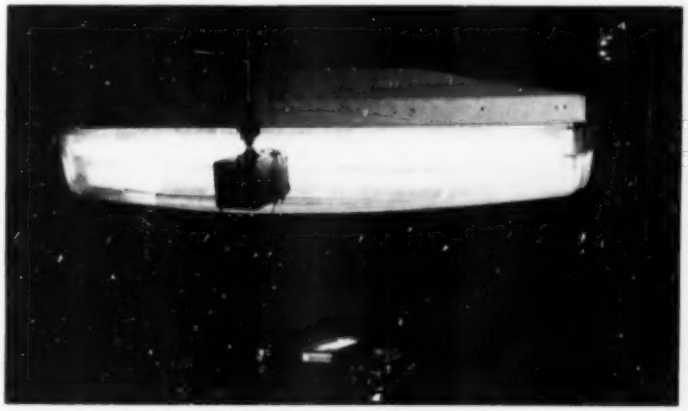


Figure 1. Luminaire, having two back-to-back reflectors, on test in normal room ambient temperature. View shows cell box (center), rigidly mounted against luminaire, and the necessary instrumentation (bottom).

from the lamps themselves, regardless of their ultimate environment, occurs when the bulb wall temperature is in the neighborhood of 100 F, which is good news to the designer of fluorescent luminaires. Curves of relative light output vs ambient temperature of the luminaire are of a real value to the ultimate user, and such information should be given by the luminaire manufacturers with photometric data of fluorescent luminaires.

With the curve of relative light output vs bulb wall temperature (Fig. 2) established, it is possible to predict light output from an enclosed street lighting luminaire at any ambient temperature, by simply measuring the bulb wall temperature at various ambient temperatures. These data combined with those shown in Fig. 2 will permit plotting curves of relative light output vs ambient temperature.

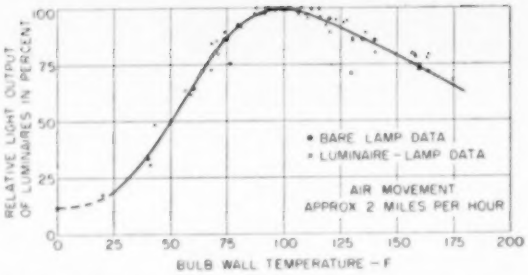


Figure 2. Light output of enclosed street lighting fluorescent luminaires as affected by bulb wall temperature. Composite curve obtained from lamps operating bare and inside various types of luminaires. Different lamp currents for the same luminaire also included.

(Abstract of I.E.S. 1953 Conference Paper No. 19)

The Development of Highway Lighting In Metropolitan Chicago And Northern Illinois

Richard J. Seitz

Edwin M. Prims

AS A RESULT of numerous studies extending over the past fifteen years, by the agencies involved in planning highways in Metropolitan Chicago, Cook County and Northern Illinois, lighting of expressways has become a reality. The first of these modern high speed roadways to be illuminated is the completed fourteen mile portion of Edens Expressway, a new limited access road runing north from the city (Fig. 1). The Cook County Highway Department, designers of this portion of the expressway, were firm in their belief that such roads should be illuminated outside the city limits and it took the opening of Edens to traffic to convince the participating agencies that lighting of these roads is essential for the safe movement of night traffic.

Much history lies behind this installation. As early as 1935 the utility and others realized that lighting of arterial roads leading into and connecting cities and municipalities was essential. One of the first substantial systems of highway lighting in Northern Illinois was installed in 1936 by the utility company on a one-mile stretch of Skokie Highway, the forerunner of the modern Chicago-land Expressway. A year later the State of Illinois installed lighting on a particularly hazardous stretch of Busse Highway, a new section of U. S. Route 12 leading west from Chicago. Largely from favorable records obtained from the Skokie and Busse lighting installations, the State of Illinois installed sodium lighting at a number of hazardous intersections in Northern Illinois.

During the war years the Cook County Highway Department in cooperation with the State, City of Chicago and the Public Roads Administration took

AUTHORS: Division Manager, Commercial Sales, and Division Street Lighting Engineer, Public Service Company Division, Commonwealth Edison Co., Northbrook, Ill., respectively.

Figure 1. Mercury vapor lighting on Edens Expressway north of Chicago — 1953.

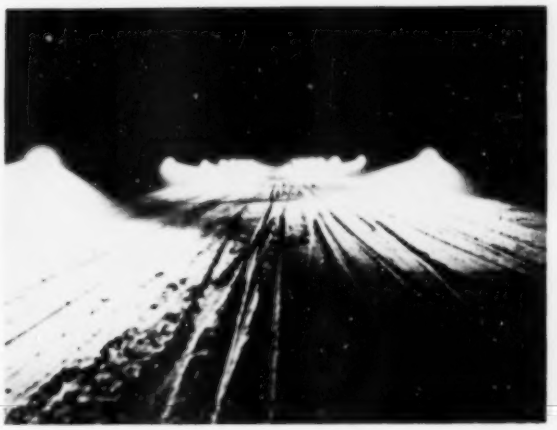


Figure 2. Low-mounted lighting study — Busse Highway, Des Plaines, Ill. — 1945.

a leading role in postwar highway planning for the Chicago area. By 1944 these agencies were well launched on a 300-million-dollar expressway program and a year later announced that Edens Expressway would be the first of the roads to be constructed.

The original plan for Edens called for the utilization of every known traffic safety feature except lighting. However, before the plans were completed, the Cook County Highway Department requested the utility and others to make a lighting study for the project.

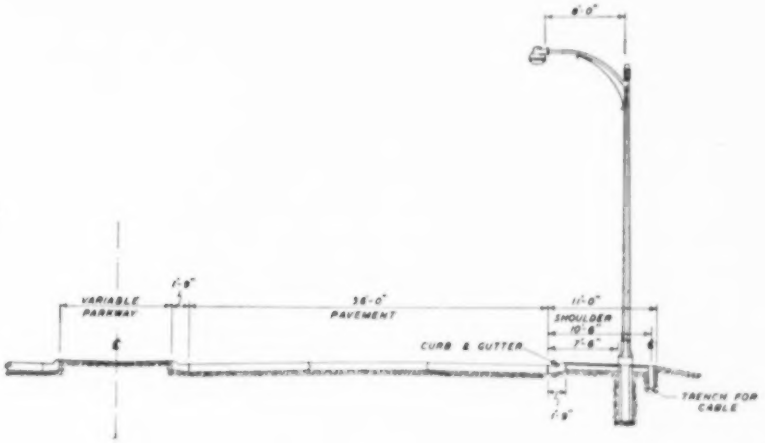
In addition to a comprehensive lighting layout using high mounted equipment, the study included the application of low mounted silhouette lighting. This latter study covered a period of six months and included an actual installation of 20 low mounted louvered searchlight type units on a 40-foot roadway which was set up to simulate one lane of a superhighway. These units were mounted six feet above pavement in a staggered arrangement 50 feet apart and were directed against traffic (Fig. 2).

As a result of these studies and the development of the mercury vapor light source, the Cook County Highway Department and its cooperating agencies accepted a proposal for continuous lighting of the expressway in accordance with American Standard Practice for Street and Highway Lighting.

The lighting system consists of 20,000-lumen mercury vapor units mounted on concrete standards at a height of 32 feet and placed along the outside edges of the roadways approximately 95 feet apart in a staggered arrangement. The standards are set back 7 feet 6 inches from the pavement edge and the lighting units suspended from the standards on 8-foot brackets (Fig. 3).

Electrical energy to the system is supplied from ten above-ground vaults placed near the pavement

Figure 3. Typical cross-section of Edens Expressway.



at about one-mile intervals. Three-wire, 240/480-volt multiple circuits extend underground from the vaults to the lighting units and are arranged so that part of the system can operate independently from the whole system.

The lighting system from each vault is controlled by a photo-electric cell and time clock. The sections now in operation are on a dusk to daylight schedule except that straight-a-way areas are lighted to about one-half normal intensity between the hours of 1:00 a.m. and 5:00 a.m. The lighting intensity on the roadway is slightly less than one footcandle except at interchanges where spacing is closer and the intensity slightly over one footcandle.

When completed the lighting system on Edens Expressway will contain 1081 units. The first section consisting of 273 units covering a distance of about three miles was placed in service March 12, 1953, and the second section of 240 units on June 22, 1953. Construction of the remaining three sections is now in progress and they are scheduled for completion in early August.

There is no doubt that lighting of Edens Expressway will have a far reaching influence on road construction practices in Illinois and other states.

As visitors from throughout the country drive over Edens Expressway and other lighted highways, there is reason to believe they will influence similar projects in all sections of the nation.

(Abstract of I.E.S. 1953 Conference Paper No. 16)

Some Observations on Fluorescent Street Lighting Here and Abroad

Philip H. Houser

EXPERIENCE to date in the application of fluorescent lamps to street lighting indicates that we, like our British and European neighbors, are about to see a rapid expansion in fluorescent street lighting.

British installations were first made in 1946 in London and Rugby. Britain now has well over 100 installations despite the government's rather severe capital investment restrictions. Rugby alone has over twelve miles of fluorescent-lighted streets.

The success and wide public acceptance of fluorescent street lighting in England encouraged the French to start an aggressive program in 1947.[1]

The French have become very enthusiastic about fluorescent street lighting and feel that it is soft, comfortable, and comparatively glareless. Paris itself now has approximately 6,000 fluorescent lamps in street-lighting service and half of its $750,000 annual budget for new street-lighting installations is being devoted to fluorescent lighting.

In 1945 the I.E.S. sponsored tests of fluorescent street lighting in Detroit, Cleveland, and Schenectady.[2] However, the United States fluorescent program did not really get started until 1950 with installations in Detroit; Lyndonville, Vermont; Portland, Oregon; and Schenectady — providing application experience and opportunity for public appraisal.[3] This experience, plus that of Britain and France, encouraged the development of a modern, streamlined, highly tooled luminaire, which was first installed in December 1952 at Oakwood, Ohio. (Fig. 1)

This latest luminaire incorporates a new rapid-start lamp and ballast system,[4] which has been coordinated with the fixture design. The variation in lumen output of this fixture over normal operating ambient conditions is considerably improved over the 1950 Slimline fixture. (Fig. 2)

The growth of fluorescent street lighting in Europe appears to be primarily a result of its outstanding seeing comfort and visibility. European experience further indicates that many criteria such as footcandles, utilization, and ratio of average to minimum used in evaluating compara-

AUTHOR: General Electric Co., Lynn, Mass.

tively small-source, high-brightness filament and mercury luminaires are not entirely indicative in evaluating long-source, low-brightness fluorescent luminaires.

As to "see-ability" on *wet* pavements the wide bands of reflected brightness achieved with fluorescent lighting are tremendously effective in silhouette seeing. In contrast, incandescent and mercury lighting are generally least effective on wet pavements. On *dry* pavements many experienced qualified observers are convinced from visual appraisals that substantially *better visibility* is obtained under fluorescent street lighting than *under equal footcandle levels* with modern incandescent or mercury installations. Some observers have expressed the opinion that *equal visibility* required at least one and a half times the footcandle level with modern incandescent or mercury as with fluorescent lighting.

Since these variances are difficult to correlate and since "seeing comfort" has not yet been fully developed as a numerical measure, fluorescent street lighting must be seen to be properly appreciated, and apparently this visual appraisal has been responsible for its rapid growth in Europe.

A similar pattern is being followed in the U. S. Many new installations now in process are directly traceable to visits made by utility and municipal groups to Oakwood.

The Oakwood populace is pleased with the visibility and "seeing comfort" of their new installation and showed their pride in it by making the dedication a gala holiday.

This community awareness and universal enthusiastic acceptance are factors that become quite important when it is remembered that street lighting, regardless of its engineering excellence, is a commodity that must be sold to, and paid for by, the public. On the basis of its performance and acceptance here and abroad, fluorescent street lighting appears to have a clearly assured future.

Figure 1. A recent U. S. fluorescent installation, Far Hills Avenue, Oakwood, Ohio.

1. Gaymard, L.: "Fluorescent Street Lighting in France," Light and Lighting (British), Vol. XLV, No. 11 (November 1952).
2. "Studies of Fluorescent Street Lighting." A report of the Committee on Street and Highway Lighting of the Illuminating Engineering Society, ILLUMINATING ENGINEERING, Vol. XLI, No. 2 (February 1946).
3. Schrenk, L. J.: "Brightness Patterns on Pavements with Elongated Light Sources," ILLUMINATING ENGINEERING, Vol. XLVII, No. 2 (February 1952).
4. Lemmers, A. E., and Brooks, W. W.: "New Fluorescent Lamp and Ballast Design for Rapid Starting," ILLUMINATING ENGINEERING, Vol. XLVII, No. 11 (November 1952).

(Abstract of I.E.S. 1953 Conference Paper No. 18)

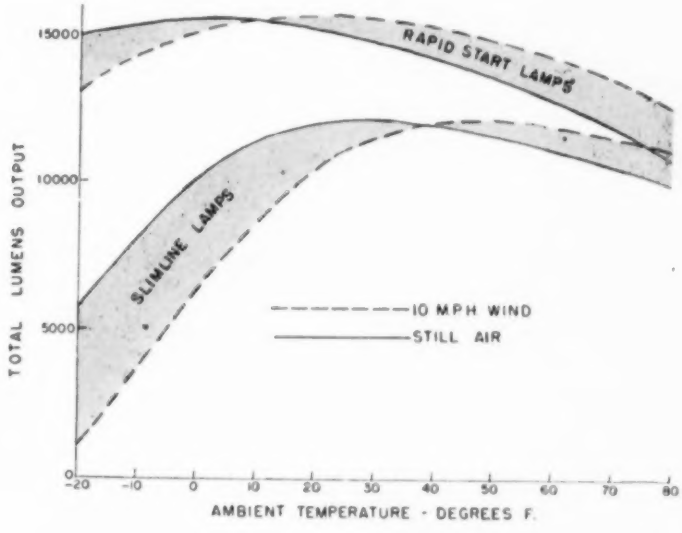


Figure 2. Variation of light output with temperature for luminaire using four 600 ma, 90-watt slimline lamps and luminaire using four 100-watt rapid-start lamps.

Light and Night Traffic Accidents

David M. Baldwin

THIRTY-EIGHT thousand men, women and children were killed during 1952 in motor vehicle traffic accidents in the United States. This is the largest total since 1941, when 39,969 persons died.

Of primary importance is the fact that 45 per cent of the total deaths during 1952 occurred during hours of daylight and 55 per cent during hours of darkness (including dusk and dawn). The year before, 1951, saw 56 per cent of the total occurring during hours of darkness, while in 1941, 58 per cent of the total were during night hours. This trend is hardly great enough to arouse either gratification or concern.

Looking at the problem in another fashion, and taking into account relative travel during hours of daylight and hours of darkness, the night accident problem becomes even more severe. Based on the best estimates available, the mileage death rate at night is about three times the rate during hours of daylight. Thus it is safe to say that one's chances of being involved in a fatal traffic accident at night are three times as great as during the daytime. The rate at night is estimated at about fourteen deaths per 100,000,000 vehicle miles and for daylight hours about five deaths per 100,000,000 vehicle miles. This same proportion holds fairly well for urban and rural experience considered separately.

It seems clear that there are a number of factors responsible for the increased accident rate at night. Different drivers, sometimes fatigued or even asleep, and sometimes under the influence of intoxicating liquor, all contribute to this experience. In addition, there is the very large and obvious factor of reduced visibility. The best evidence that the change in visibility contributes to increased night accident experience lies in the many examples of accident reduction following efforts to increase night illumination. Street lighting improvements have almost universally been followed by fewer accidents and deaths. Perhaps even drunken drivers are better drivers when they can see where they are going.

This experience of accident reduction following the installation of adequate street lighting is well-known. Detroit's experience has been established over a period of many years. Milwaukee, Kansas City, and many others have set substantial records in this area. Chicago is well on its way. The evidence is clear that adequately lighted streets bring about reductions in traffic accidents.

It is obviously impossible to attempt to assign any relative values to the influence exerted on the night accident rate by any of the factors mentioned. We cannot, for instance, say that alcohol is a ten per cent factor, fatigue a five per cent factor, reduced visibility a fifty per cent factor, and so on. We do believe that all are factors and that any well-rounded accident prevention program must recognize that all are factors. Looking at the matter from that standpoint, the question then becomes one of what can be done about the situation.

Certainly the most direct and obvious approach is that of providing improved street lighting. None of the other problems offers an opportunity for such a direct approach toward a solution. Every city should examine critically its present street lighting program in comparison with I.E.S. standards and embark upon a program to bring lighting on its high-accident streets up to par. We know the results will be evident in a lower accident rate, in longer life and greater happiness for the citizens of the community.

(Abstract of I.E.S. 1953 Conference Paper No. 17)

AUTHOR: Director, Traffic Division, National Safety Council, Chicago, Ill.

From the Session on

Daylighting

Left to right:

H. F. Kingsbury

W. H. Billhartz

R. W. McKinley

Functional Top-Lighting With Glass Blocks

THE PRINCIPLE of optical control and thermal insulation found in functional glass block as we know them today provide an avenue to improved skylight design. They lead to a solution of the problems of glare, condensation, and temperature control. Basic illumination data on this new skylight design are shown as well as how it may be combined with electric lighting in low ceiling areas to provide a single day plus electric lighting source.

Glass blocks form an excellent medium for the admission of daylight to top-lighting panels as well as through sidewalls. Laid up in horizontal reinforced concrete panels they resist the elements and the loads typical of roof usage and provide more than twice the resistance to heat transmission provided by single glazed skylights. Because of their durable enclosed optical surfaces, they can be designed for brightness control with the assurance that the distribution characteristics will not be greatly changed by dirt collection or changes in structure. Many European installations of glass block-concrete panels have served satisfactorily for a number of years.

AUTHORS: Product Development Engineer, Product Development Physicist, Pittsburgh Corning Corp., Port Allegany, Pa., and Development Engineer, Pittsburgh Corning Corp., Pittsburgh, Pa., respectively.

With the 12-inch hollow glass block around which the new system is designed, the joint width can be anywhere from the minimum 2¼ inches, to any practical maximum that may be desired. Such design freedom allows the architect or lighting engineer to predetermine the glass area required and then plan the top-lighting panels and layout on the basis of light distribution, aesthetics, or required building dimensions. The block design consists of etched interior surfaces, a fibrous glass screen between the halves, and a cylindrical lens surface on the interior face. The top exterior face

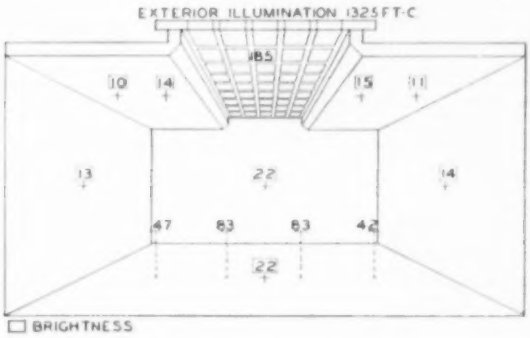


Figure 1. Brightness and illumination distribution in a room 20 feet square with 10-foot ceiling height, top-lighted with a panel of 12-inch glass block, 5 blocks wide x 15 blocks long.

is smooth for easy construction and maintenance cleanability.

The illumination data presented in the paper are based on calculations made from information found in the *I.E.S. Lighting Handbook* and from direct measurements made in a 20-foot-square test room which is completely top-lighted using the new block design and 3¼-inch concrete joints.

As an example of the type of lighting that can be obtained see Fig. 1. The measurements were made using the Photo Recorder, described in a previous paper,[1] so that data for a wide range of exterior conditions, including both overcast and sunny days, could be very easily made.

Design information is included to assist the illumination engineer or architect in designing a glass block skylight for use in his buildings.

1. Billhartz, W. H., Kingsbury, H. F., and McKinley, R. W.: "A New Daylighting Survey Technique Utilizing a Photographic Recorder and Physical Brightness Meters," ILLUMINATING ENGINEERING, Vol. XLVIII, No. 1, p. 6 (January 1953).

(Abstract of I.E.S. 1953 Conference Paper No. 27)

Daylighting with a New Kind Of Functional Skylight

R. A. Boyd

John Lyon Reid

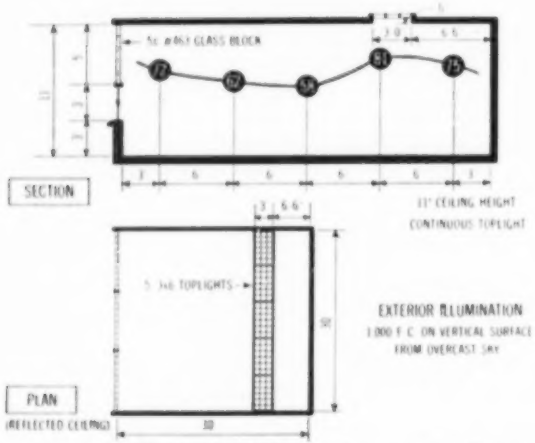


Figure 1. Illumination data for classroom or office.

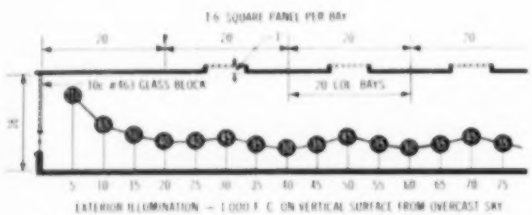


Figure 2. Illumination data for typical factory or shopping center.

THIS PAPER describes the design and construction of a new type of functional skylight. This material is the result of more than two years of research work by the Daylighting Laboratory of the Engineering Research Institute at the University of Michigan. The material is available in prefabricated panels, 3 x 3-foot, 3 x 6-foot and 4 x 4-foot. The unit has been designated as a top-lite and it is functional in that it is selective in its transmission of daylight and specifically distributes the transmitted light about an interior. When installed in the roof of a building it transmits a relatively large amount of light from the low winter sun and light from the north sky but rejects most of the light from the high summer sun. The brightness of the material for all of the usual angles of view is well within acceptable limits. This toplite has many applications but it is considered to be especially suitable to be used in conjunction with light-directing glass block in exterior walls of buildings.

Fig. 1 shows the daylighting for an average overcast day of a classroom or office that is 30 feet deep with a ceiling height of 11 feet; the room being

AUTHORS: Daylighting Laboratory, University of Michigan, Ann Arbor, Mich., and Architect, 1069 Market St., San Francisco, Calif., respectively.

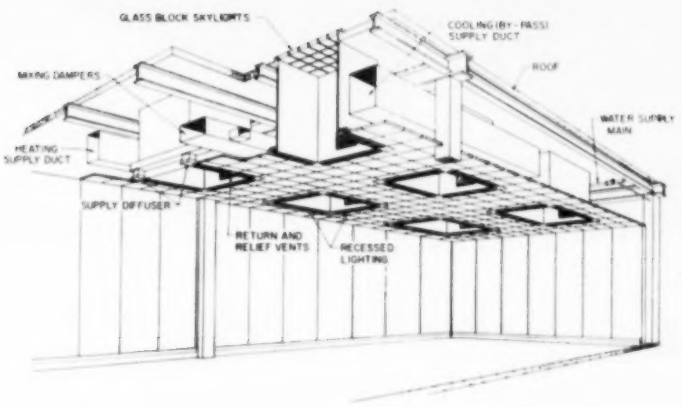


Figure 3. Coordination of facilities within building unit.

decorated such that the average reflectances of the ceiling, walls and floor are 85, 72 and 30 per cent respectively. The main fenestration consists of five courses of 12-inch light-directing glass block, above a shielded clear flat glass vision strip and the auxiliary fenestration is a ribbon of toplites 3 feet wide extending parallel to and 6½ feet in front of the wall opposite the main fenestration.

Fig. 2 shows the predicted daylighting of a factory or shopping center that has one 6 x 6-foot toplite panel in each 20 x 20-foot interior bay, in addition to ten courses of 12-inch-direct directing block above a clear flat glass vision strip in the outside walls.

One of the first applications of the toplite will be in the Hillsdale High School of San Mateo, California. Fig. 3 shows the location of these glass block skylights in the roof of a typical classroom of this school.

(Abstract of I.E.S. 1953 Conference Paper No. 28)

Daylighting with Plastic Domes

B. F. Greene

ARCHITECTS and engineers are becoming increasingly aware of the value of careful design of interior spaces for proper daylighting; for a good daylighting arrangement pays dividends throughout the life of a building.

The daylighting fixtures to be discussed in this paper are plastic domes (Fig. 1). The unit is a skylight consisting of a plastic dome, either translucent or clear, surrounded by a metal frame. Circular units are available in 3-, 4-, and 5-foot diameters, square units in 2-, 3-, and 4-foot squares, and rectangular units in sizes ranging from 2 x 2½-foot to 5 x 8-foot. The domes are vacuum drawn from a single piece of acrylic plastic. It has been found that the dome or bubble shape is most desirable because of its high strength, pleasing appearance and good maintenance.

The light distribution from a single translucent skylight dome can be assumed as being similar to that from a surface source. This applies whether the primary source of light is an overcast sky or a

AUTHOR: Consulting Engineer, 100 West 42nd St., New York, N. Y.

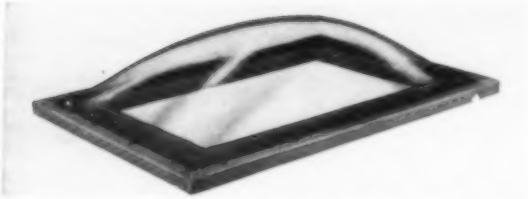
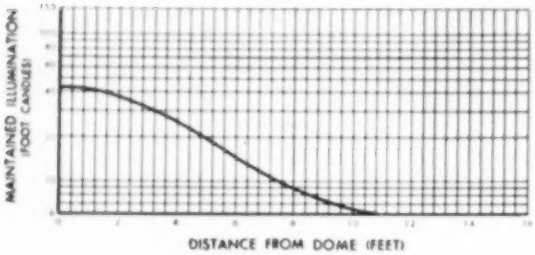


Figure 1. A typical clear plastic dome in its metal frame.



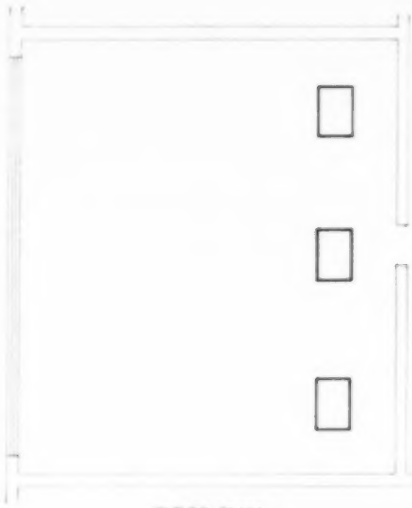
CURVE OF ILLUMINATION VERSUS DISTANCE FROM DOME

Figure 2. Illumination distribution from a single 4-foot-square translucent dome. The assumed sky brightness was 1000 ft-L.

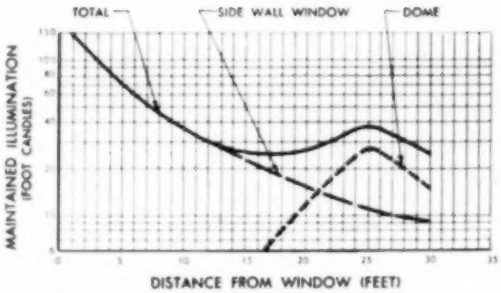
clear sky together with direct sunlight, which is diffused by the white plastic. Using the curves calculated for obtaining illumination from a surface source[1] the light distribution curve (Fig. 2) was obtained. This curve was calculated for a 4 x 4-foot translucent skylight dome, assuming an equivalent sky brightness of 1000 footlamberts, and a mounting height of 10 feet above the working plane. In this instance, the effect of room reflectance, and of the light well in which the dome was mounted, was not considered. Where a number of domes are used, then the illumination can be obtained either by point by point calculation using calculated distribution curves of single units, or by use of the interreflection method.[2] When skylight domes are the sole source of illumination, then the interreflection method is the most convenient to use, as it allows for different room reflectances.

Skylight domes have been found to be effective for complete daylighting of an interior, and as an adjunct to side-wall windows. With unilateral sidewall fenestration, the illumination is at a maximum near the window and decreases as the distance from the window increases. With a daylighting fixture, such as the skylight dome, the daylight can be put where needed so as to result in uniform illumination distribution.

For rooms without side-wall windows, the domes can be placed uniformly throughout the area, similar to the design of an artificial lighting system.



FLOOR PLAN



CURVE OF ILLUMINATION VERSUS DISTANCE FROM WINDOW

Figure 3. Classroom with sidewall windows in which domes are used for supplementary illumination. Window height is 7 feet, and there is a 4-foot overhang. Three 3 x 4-foot translucent domes are used to give illumination distribution as shown in the graph.

In general, the spacing between domes should not exceed 1½ times the ceiling height, while the spacing between the first row of units and the wall should be ½ of this value.

Fig. 3 illustrates the use of skylight domes as an adjunct to side-wall lighting. Where the room is not deep in comparison with window height, one row of domes is all that is required. For deeper rooms, two or more rows of domes may be required.

A relatively new field of daylighting design is open to illuminating engineers. Using methods similar to that used for artificial lighting design, interiors can be well lighted throughout the day.

1. Moon, Parry: *The Scientific Basis of Illuminating Engineering*, McGraw-Hill Publishing Company, Inc., 1936.
2. Moon, Parry, and Spencer, D. E.: *Lighting Design*, Addison-Wesley Press, Inc., 1948.

(Abstract of I.E.S. 1953 Conference Paper No. 29)

From the Session on

Measurements

An Instrument for the Evaluation Of Night Visibility on Highways

A. E. Simmons

D. M. Finch

THE APPRAISAL of a highway lighting installation is most difficult at the present time, for there is no straightforward technique available to arrive at an objective evaluation of a given lighting job. It is the object of this paper to describe one technique that appears to have merit for the evaluation of actual lighting installations. The development work has been under the sponsorship of the I.E.S. Research Fund and the University of California. The basic design conditions for street and highway lighting are adequately presented in the American Standard Practice for Street and Highway Lighting, 1953, but it remains a problem to interpret the general requirements in terms of practical layouts and actual installations. One problem is to measure the visibility of objects on the roadway with a technique that eliminates subjective appraisal as much as possible. Inherently visibility is subjective and as such it defies measurement directly. Therefore, we can only use indices that can be correlated to visibility in order to objectively quantify the term. For our studies the contrast threshold has been selected as the most representative phenomena to measure for the highway situation at night and is the basis for the technique reported in the paper. An instrument is described that uses the contrast threshold as the basis of measurement and maintains the eye adaptation at a constant value, limits the measuring field to a small central area of approximately 3 to

AUTHORS: Division of Highways, State of California, San Francisco, Calif., and Institute of Transportation and Traffic Engineering, University of California, Berkeley, Calif., respectively.

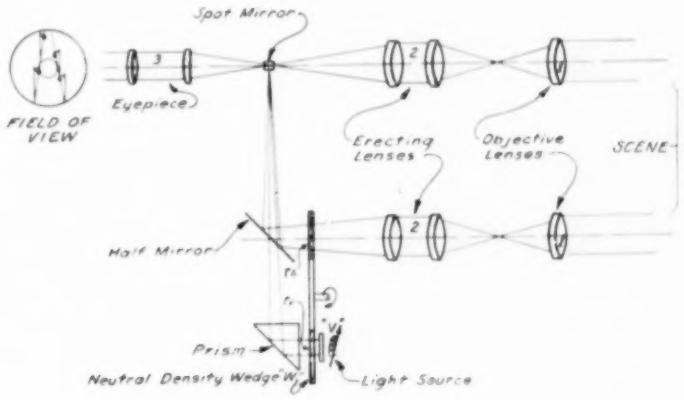


Figure 1. Instrument design.

5 degrees in total visual angle, changes the contrast in this small central field without affecting the surroundings and without scattering or changing the average brightness of the central field. The total visual field is designed to take in the normal highway scene and to include all of the brightness variations normally viewed including glare sources in the immediate field of view. The contrast threshold measurement does not modify the external field, but merely changes the contrast within a small central section of the field. Details of the instrument are presented together with a brief theoretical analysis of the method of changing contrast. Also preliminary data are shown for the instrument used in both laboratory and field visibility studies. It may be noted from the instrument readings that good correlation is obtained between visual appraisals of the tasks involved and the meter readings obtained on the instrument. Further tests are underway to verify the design and the measuring technique described.

(Abstract of I.E.S. 1953 Conference Paper No. 25)

C. M. Holden

The Effect of Ambient Temperature On Fluorescent Lamp Performance

CONTINUED research is constantly bringing forth more information which makes it possible to predict with greater accuracy the outcome of a proposed lighting installation. With all the possibilities that now can be considered, the temperature factor in a fluorescent lighting system is very seldom applied. It is a well recognized fact that ambient temperature affects the light output of these lamps. Because the information available may have been of too general a nature, it was considered of value to the lighting industry if data on light output versus lamp ambient temperature could be supplied for specific lamps of the more popular types in use today.

To present these data in the form of easily understood curves, the author conducted many tests in specially designed equipment to determine the effect of ambient temperature on 40-watt T12, 85- and 100-watt T17, bipin preheat, 96T12 and 40-watt rapid start lamps. A special box was constructed to contain any of these lamps. The inside of the box was covered with two coats of flat camera black paint. Two 500-watt strip heaters were mounted at the bottom of the box so they extended practically the entire length. An insulated platform was placed above the heaters to shield the lamps and the recording devices from the direct radiation of the heaters. The space underneath this also provided room for finely chopped dry ice in order to obtain the low temperature measurements. Sockets were mounted on the lid of the box to accommodate two lamps of each type being tested. Midway between these lamps, a slot was cut in the lid to hold a type PV1 light cell which was checked periodically to obviate any inaccuracies which might be caused by exposure to extreme temperatures. Fig. 1 shows a view of the box open. Several thermometers were inserted in the box for comparison purposes. The ballast was placed in a separate box mounted over an opening in the lid of the test box so that air circulation from the lamps was vented through the ballast enclosure.

Fig. 2 shows average light output versus temperature curves for the five types of lamps investigated. Each curve is the average of several runs using the type of lamp for which the curve is labeled. Table I gives these data in chart form.

These tests confirm previous general knowledge regarding the effect of temperature on fluorescent lamp performances and the fact that low temperatures affect lamp output more drastically than higher temperatures. They provide concrete data which can be applied to specific lighting calculations. For indoor operation, ambient temperature at body height will range from 70 to 80F. Lamps in their normal location near the ceiling will oper-

AUTHOR: Commercial Engineering Department, Champion Lamp Works, Lynn, Mass.

TABLE I.—Tabulation of Per Cent Light *vs* Temperature for All Lamps Tested.

Average Relative Light Output

Ambient Temp. °F	40T12/CW Preheat	96"T12/CW Slimline	90T17/CW Preheat	100T17/CW Preheat	40W RS/CW Rapid Start
−20			6.5%	4%	
−10			9.5%	7.5%	
0			14%	14.25%	
10	11.5%	11%	21%	26%	5.75%
20	17%	19%	32.5%	46.5%	12%
30	40%	39.5%	48%	71%	26%
40	75%	76%	65.5%	84.5%	72.5%
50	89%	91.5%	81%	93%	92.5%
60	97.5%	98.5%	93%	98%	98.5%
70	100%	100%	100%	100%	100%
80	98.5%	99%	97%	96.5%	99%
90	96.5%	97%	91.5%	90%	96.75%
100	93.5%	94%	86.75%	84%	93.5%
110	90%	91%	83%	78%	90%
120	86%	88%	79%	72%	85.75%
130	82.5%	85%	75.75%	66.5%	81.5%
140	79%	82%	72.5%	62%	77.5%
150	75.5%	79%	69%	58.5%	73.75%
160	72%	76%	66%	55%	70%
170	68.5%	73%	63%	52%	66.75%
180	65.5%	70%	60%	49.5%	63.75%
190	62.5%	66.75%	57.25%	47.5%	61%
200					58.75%

ate at temperature levels 10 to 15 degrees higher than table height. The fixture enclosure increases this temperature still further. Consideration of the accumulative temperature conditions in a three-lamp closed end industrial unit might be as follows. Room temperature at desk height is 75F. A 10-degree rise at fixture level would mean a fixture ambient of 85F. The *I.E.S. Lighting Handbook* shows an increase of 35F. from fixture ambient to lamp ambient for this particular unit and lamp ambient would be in the vicinity of 120F. Table I shows 72 per cent relative light output for the

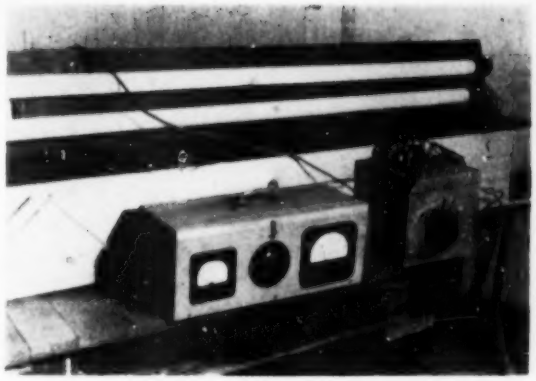


Figure 1.

100-watt T17 and 88 per cent for the 96T12 at this temperature. Therefore, without any other considerations, the lamps are producing 12 per cent to 28 per cent less light than the maximum figures for these lamps. Some types of fixtures will produce appreciably higher lamp temperatures and some lower, but it is very obvious that more serious consideration must be given to this condition, which, for the lack of a better name, we might call the "Operation Factor."

The author sincerely hopes that these data will now make available information which will enable the lighting engineers to design installations and predict their results with considerably greater accuracy for the benefit of all.

(Abstract of I.E.S. 1953 Conference Paper No. 21)

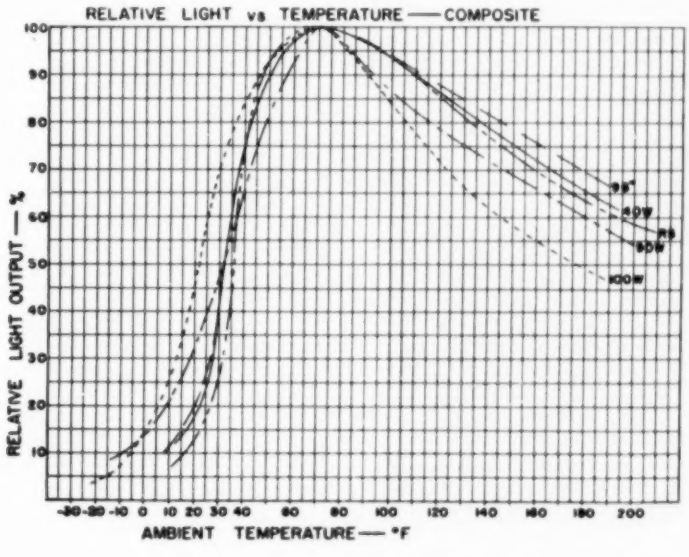


Figure 2.

Effect of Temperature on Electrical And Color Parameters of 40T12 Fluorescent Lamps

Charles W. Jerome

VARIATIONS in ambient temperature have been found to have an appreciable effect on both the color and efficiency of fluorescent lamps. The effect on efficiency has been studied extensively and the results have led to a continual urging of fixture manufacturers to provide adequate ventilation in enclosed fixtures in order to take advantage of the increasing efficiency which the lamp manufacturers have worked so hard to acquire.

The effect of ambient temperature on color is not so well documented and heretofore little data were available on which to predict the color shifts which might be expected with variations in ambient temperature.

The present study was undertaken to obtain quantitative data on the performance of present day lamps and to determine the cause of the observed color shifts in order to minimize or eliminate them. Only 40WT12 lamps were used in this study. The effect of temperature on the performance of other sizes is similar in nature with minor variations.

A 40T12 fluorescent lamp was fully enclosed and the ambient temperature within the enclosure controlled by a stream of compressed air passed through a temperature control unit. A window in the enclosing box at the center of the lamp allowed light to fall on the entrance slit of a spectroradiometer by which the spectral energy distribution of the emitted light was measured. A thermocouple hung in the air stream at the midpoint along the lamp measured the ambient temperature.

At each new ambient temperature the system was allowed to come to equilibrium, the electrical parameters of the lamp (current, lamp volts, and lamp power) were noted and the spectral energy distribution determined. Measurements were made on each lamp at between 10 and 15 ambient temperatures covering the range −10C to 115C. The color parameters for the C.I.E. color mixture diagram of the phosphor emission, mercury arc, and lamp were computed from the SED curves. In this

AUTHOR: Sylvania Electric Products, Inc., Salem, Mass.

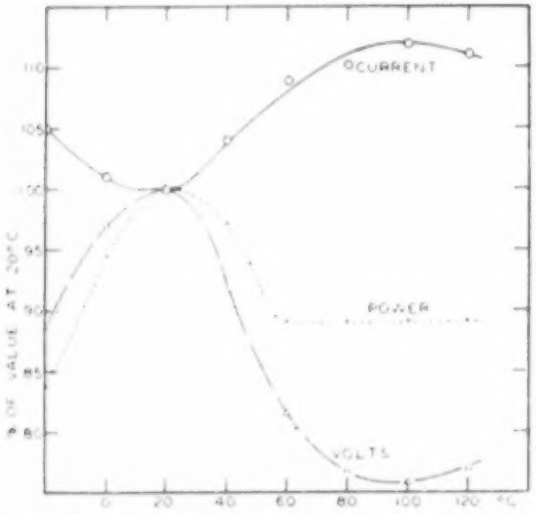


Figure 1. Effect of temperature on electrical parameters (average of all lamps).

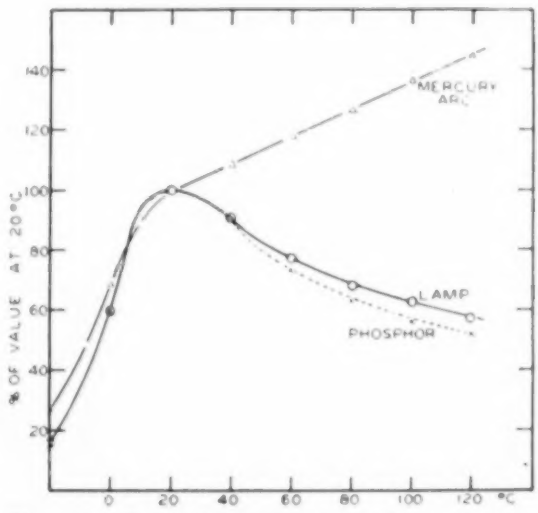


Figure 2. Effect of temperature on brightness (average of all lamps).

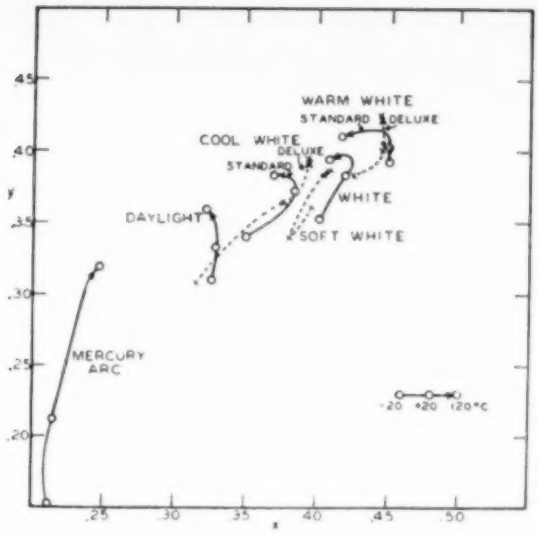


Figure 3. Lamps and mercury arc on C.I.E. color mixture diagram.

process, the integral, $\int E_\lambda y d\lambda$, is evaluated for each component, and this value was taken as the measure of the relative brightness.

The effect of temperature on the electrical parameters of the lamps is shown in Fig. 1. From this figure, it is obvious that an ambient temperature of 20C is the temperature for most efficient operation.

The effect of temperature on the brightness of the lamps is shown in Fig. 2. The percentage variations of all the lamps with temperature were very similar despite the use of different phosphors. It is, therefore, concluded that the effect shown is primarily due to variations in the intensity of the actinic radiation of the mercury arc and not due to the effect of temperature on the phosphor itself.

The effect of temperature on the color of the lamps tested is shown in Fig. 3. The very large color shift in the mercury arc induced by temperature is particularly interesting. This shift is many times larger than the shifts induced in the colors of the phosphors, and accounts for most of the color shift in the lamps. The curvature towards the blue at high temperatures in the lines denoting the color shifts of the lamps is due to the increasing brightness of the mercury arc and the decreasing brightness of the phosphor emission in this region as shown in Fig. 2.

These data indicate that fluorescent lamps operate most efficiently at ambient temperatures very close to 20C. Each rise of 20C above this point results in a decrease in brightness of approximately 10 per cent. Therefore, fixture manufacturers can realize a considerable saving in light output by providing adequate ventilation around the lamps to carry off the heat generated in their operation. On the other hand, fixtures for use in low temperatures should be fully enclosed to conserve the generated heat, provided such action does not raise the ambient temperature above 20C.

(Abstract of I.E.S. 1953 Conference Paper No. 22)

Rectangular Coordinate Photometer For Large-Area Luminaires

LUMINAIRES are now made in such large sizes that the classical (spherical coordinate or point source) photometries cannot be relied upon to give accurate results in ordinary rooms. Apart from this theoretical consideration, it would be difficult practically to build a goniometer for the photometry of such luminaires.

A "rectangular coordinate" photometer predicated on the parameters of the Interflectance method was designed and built for the purpose of

J. A. Losh

AUTHOR: Smithcraft Lighting Div., A. L. Smith Iron Co., Chelsea, Mass.

obtaining data on a 12-foot-square "luminaire." The entire laboratory was 15 x 16 feet, 10 feet high. The photometer was 12 feet square and 8 feet high. Classical photometrics would have required a test distance of at least 85 feet.

A cosine-corrected, color-corrected light meter was used to take readings of incident illumination on each one-foot square of the walls and floor. The sum of these readings equals the output of the luminaire. Lamp outputs were measured with a special instrument similar to the "pharometer" described by Coradeschi and Innis. No other instruments were required.

The quotient of luminaire output to lamp output is the efficieney of the luminaire. A simple operation on the measured data, which is described in detail in the paper, allows the calculations of interflectances (Utilization factors) for all room shapes and surface reflectance combinations. Equations are also available to enable the calculation of efficieney for any size of ceiling. The product of efficieney and interflectance is the coefficient of utilization. Because any size or depth of cavity can be coupled to any size room, there is no unique relationship between interflectance and efficieney, and the product must be made for each particular set of conditions.

Results predicted by the measurements were checked against measurements in a light-conditioned room and were found to be in excellent agreement, although the results were at a wide variance with the predictions of the Harrison-Anderson data. This is to be expected because the latter data are based on point-source photometries, and cannot be extended to large area luminaires.

(Abstract of I.E.S. 1953 Conference Paper No. 24. Just prior to press-time this paper was transferred to the session on Utilization.)

Karl Freund

Design Characteristics of a Photo-Electric Brightness Meter

A NEED has frequently been indicated by various groups for an instrument that would measure the brightness of small areas from a distance and still be sensitive enough to read down to a few footlamberts or less. The paper describes the development and characteristics of such an instrument.

The Spectra Brightness Spot Meter, as it is called (Fig. 1), is a direct reading instrument with the extremely small acceptance angle of only one and one-half degrees. It will measure brightnesses from one-tenth (0.1) of a footlambert up to one million (1,000,000) footlamberts. The optical system of the meter consists of a four-element f 1.9 lens in focusing mount which forms an image of the region to be measured on a reticule in the optical housing. A circle in the center of this plate indicates the exact extent of the area being measured. This image is viewed magnified through a telescopic eye-piece. A partial reflecting mirror just ahead of the reticule plate reflects a portion of the light downward to the photo tube. An opaque aperture plate is located at the focus of this light beam directly above the photo tube. This plate excludes all light except the portion of the image that corresponds to that within the circle of the reticule. The light emerging from this aperture passes through a filter wheel and then on to the cathode of the photo tube. The output from the photo tube passes through the resistor selected by the range switch. The voltage produced in this resistor is duplicated with a current amplification of as much as one million times by a special electrometer tube amplifier. This output current is then read on a logarithmic response microammeter which is calibrated to read directly the footlambert brightness of the surface viewed. The scale is calibrated from 1 to 100 footlamberts.

When scanning with the instrument on a tripod the meter can be made to read continuously by merely depressing and then turning a button. The logarithmic scale makes the percentage accuracy approximately uniform over the entire length of

AUTHOR: Photo Research Corp., Burbank, Calif.

Figure 1. The meter with hand grip. Weight is about five pounds and measurement range is from 0.1 to 1,000,000 ft-L.

the scale. Accuracy is better than five per cent of reading over the entire range of sensitivity and is maintained throughout the life of the batteries (Fig. 2).

Where highest accuracy is desired, supplementary lenses should be used with reading areas closer than six feet. The first such lens covers an area of one and one-half inches at five feet, a second covers one inch at forty inches, a third one-half inch at twenty inches, a fourth one-quarter inch at ten inches, and the fifth is a four-element supplementary lens covering an area of one-tenth of one inch in a diameter at a little over two inches in front of the supplementary lens. Brightness of a very small area such as luminous markings on dials can be thus measured. When the meter is to be used continuously for long periods of time at a single location, an external power supply operating from 60-cycle line current may be used to replace the batteries.

An application of special interest, particularly with the present trend to wide screens, 3-D screens and the like, is its use in screen brightness measurements. Being small, light, and requiring no external power, it can be taken anywhere in the auditorium so that the screen brightness can be measured from any viewing angle. The small angle of view means that not only can the average brightness be read from each angle but the evenness of the light reflected in that direction over the screen area can be measured. If a patch of known reflectance and color of sufficient size to fill the angle of view of the meter is placed against the screen, the footcandle level of illumination produced by the projector at the screen can be read. By comparing the readings of this standard patch with that of the screen measured through each of the primary color

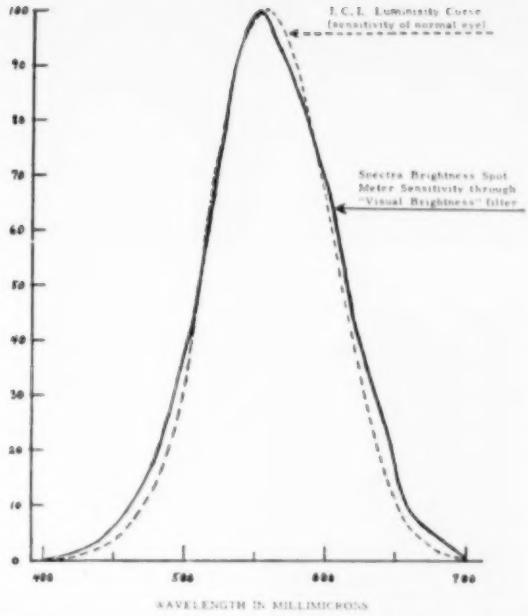


Figure 2. Showing the accuracy to which the sensitivity of the instrument matches the C.I.E. luminosity curve when on the "visual brightness" position.

filters, the reflectance of the screen and amount of color modification produced by the screen can be measured.

Doubtless numerous other uses will be suggested when the meter comes into more general use, as this is the first commercial instrument for measuring the brightness of small areas which eliminates the errors inherent in visual methods.

(Abstract of I.E.S. 1953 Conference Paper No. 26)

I.E.S. Emblem

The official emblem of the Illuminating Engineering Society is available to members in 14-karat gold, lapel screw back buttons, in the miniature ½" size, at only $3.50 each including taxes. Blue background for Members, red background for Associate Members. Order from Illuminating Engineering Society, General Office, 1860 Broadway, New York 23, N. Y.

From the Session on

Evaluation

H. L. Logan

The Orientation Reflex

A CLOSE relationship exists between light and human survival. This relationship is particularly evident in common types of accidents, although it also exists in connection with health, and more obscurely, but definitely, in connection with length of life.

Lighting systems affect involuntary human action through the orientation reflex. When normal people fail to avoid hazards that operate more slowly than the orientation reflex, the cause may lie in visual clues that are inadequate to trigger the involuntary reflex; or from misleading visual clues that trigger a defective involuntary response.

There is among lighting engineers little awareness of the extensive degree to which the operation, regulation and control of the motor system of the body is subservient to the visual sense. When visual energy enters the organism it initiates a chain of events. Nerve currents go to the thalamic region in the brain and then branch out in a number of directions. One of these directions is to the cortex, and our concept of brightness is determined by the operation of this derivative of the original stimulus, as this is its only product that reaches a part of our organism where it can be consciously identified and evaluated.

The other and probably major products of the stimulus go to lower centers in the brain, such as those that operate the motor and regulating systems of the body, or that generate feelings. In short, when *light* enters the body it does a number of things apart from communicating optical information about the environment. The most important thing it does is to operate our orientation system.

The visual sense is thus, in a very real way, a dominating factor in human life. On the voluntary level it is the principal means of contact and communication with the external world; and on the involuntary level it is the means by which the external world "push-buttons" people, so-to-speak, into safe, survival-type reactions during their daily activities.

Therefore, the manner in which engineers light the external world not only affects the ease with which people communicate with it, but may affect

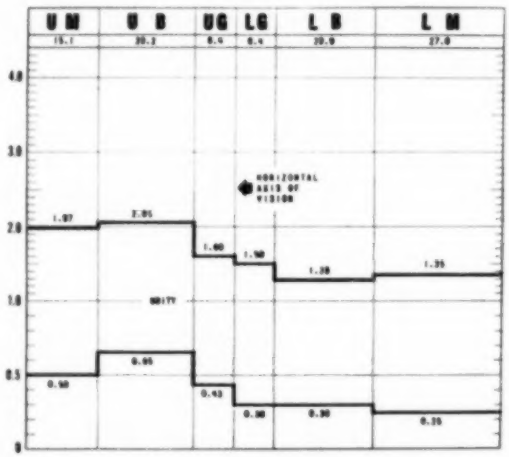


Figure 1. Flux diagram. The two heavy guide lines that cross this diagram show the maximum and minimum relative quantities of light from each part of the field of view to which normal people are fully adapted, as determined by the investigations of the author and reported in previous issues of ILLUMINATING ENGINEERING.

AUTHOR: Vice-President in Charge of Research, The Holophane Company, New York, N. Y.

their health, may contribute to keeping them free of injury or not, and may be a factor in determining whether they continue to live past a specific emergency or not.

With respect to the orientation reflex "only differences in density of luminous flux entering the eyes are "effective." That is the involuntary response is dependent on the flux and not the brightness relations. The flux diagram therefore offers a means for a determination of light-connected accident potentialities in visual fields, where they originate from inadequate visual clues. Specific applications are described in the paper.

Misleading visual clues are also described and illustrated and the paper closes with a statistical correlation of available data on accident rates and related lighting levels pointing to the possibility that safety lighting levels should be in the neighborhood of 100 to 150 footcandles.

(Abstract of I.E.S. 1953 Conference Paper No. 7)

Comparative Analysis of "Comfort" and "Glare "

Domina Eberle Spencer

RECENT issues of ILLUMINATING ENGINEERING indicate a healthy interest in high-quality lighting. Unfortunately, they also reveal some misconceptions that may act as barriers to future progress. The most popular hypotheses with respect to the study of quality lighting are that

(1) The line of sight may be considered fixed,
(2) The instantaneous state of adaptation of the eye may be neglected,
(3) "Glare" may be dissected into "discomfort," "disability," "direct," and "reflected glare"; and these subdivisions may be considered separately.

The paper points out some of the paradoxes implicit in current schemes of analyzing "comfort" and "glare." Such systems may be classified as the *glare rating method*,[1] the *BCD approach*,[2] and the *zonal flux method*.[3]

The paper shows that the first method rates all daytime fields of view as intolerable. Even the most comfortable outdoor scenes have glare ratings from 200 to 1500. The second method is based on inadequate data and, even with consistent data, could only tell whether the lighting system would be comfortable if it were flashing at one-second intervals. The third method analyzes the surround in terms of zonal flux, a quantity which has no visual significance. Thus the third method does not distinguish between an attractive outdoor scene, and a black room containing a set of properly adjusted spotlights. All three of these methods ordinarily make the unrealistic assumption that the eye is fixed with a horizontal line of sight. All neglect the actual state of adaptation of the eye. They cannot be considered to form a reliable basis for lighting design. A system more closely related to human vision is needed.

The paper shows that a proper interpretation of the 3:1 ratio, originally recommended by the first Committee on Standards of Quality and Quantity of Interior Illumination,[4] provides a sound and simple basis for analyzing the quality of a lighting system. The proper interpretation differs from that sometimes attributed to the report in that eye motions and the actual state of adaptation of the fovea must be taken into account.[5]

AUTHOR: Associate Professor, University of Connecticut, Storrs, Conn.

1. Harrison, Ward: "Glare Ratings," ILLUMINATING ENGINEERING, Vol. XL, p. 525 (1945); Harrison, Ward, and Meaker, Phelps: "Further Data on Glare Ratings," ILLUMINATING ENGINEERING, Vol. XLII, p. 153 (1947); Meaker, Phelps: "Brightness vs Area in the Glare Factor Formula," ILLUMINATING ENGINEERING, Vol. XLIV, p. 401 (1949); Holladay, L. L.: "Fundamentals of Glare and Visibility," *Journal of the Optical Society of America*, Vol. 12, p. 271 (1926); Luckiesh, Matthew, and Guth, S. K.: "Discomfort Glare and the Angular Distance of Glare Source," ILLUMINATING ENGINEERING, Vol. XLI, p. 271 (1946); Harrison, Ward: Discussion of "Glare Ratings," ILLUMINATING ENGINEERING, Vol. XL, p. 555 (1945); Harrison, Ward: "Are Comfort Rating Systems Ready?" ILLUMINATING ENGINEERING, Vol. XLVII, p. 254 (1952).
2. Luckiesh, Matthew, and Guth, S. K.: "Brightness in Visual Field at Borderline Between Comfort and Discomfort (BCD),"

ILLUMINATING ENGINEERING, Vol. XLIV, p. 659 (1949); Guth, S. K.: "Comfortable Brightness Relationships for Critical and Casual Seeing," ILLUMINATING ENGINEERING, Vol. XLVI, p. 65 (1951); Guth, S. K.: "BCD Brightness Ratings in Lighting Practice," ILLUMINATING ENGINEERING, Vol. XLVII, p. 184 (1952); Putnam, R. C., and Faucett, R. E.: "The Threshold of Discomfort Glare at Low Adaptation Levels," ILLUMINATING ENGINEERING, Vol. XLVI, p. 505 (1951); Petherbridge, P., and Hopkinson, R. G.: "Discomfort Glare and the Lighting of Buildings," *Transactions of Illuminating Engineering Society* (London), Vol. 15, p. 39 (1950).

3. Logan, H. L., and Lange, A. W.: "The Evaluation of Visual Comfort Data," Vol. XLVII, p. 195 (1952); Logan, H. L.: "Specification Points of Brightness," *I.E.S. Transactions*, Vol. XXXIV, p. 881 (1939); Logan, H. L.: "The Anatomy of Visual Efficiency," ILLUMINATING ENGINEERING, Vol. XXXVI, p. 1057 (1941); Logan, H. L.: "Light for Living," ILLUMINATING ENGINEERING, Vol. XLII, p. 291 (1947); Logan, H. L.: "The Practical Mechanics of Designing Optimum Lighting Patterns," ILLUMINATING ENGINEERING, Vol. XLIII, p. 1233 (1948).

4. Report No. 1 of the Committee on Standards of Quality and Quantity of Interior Illumination of the Illuminating Engineering Society, ILLUMINATING ENGINEERING, Vol. XXXIX, p. 713 (1944).

5. Moon, Parry, and Spencer, D. E.: *Lighting Design*, Addison-Wesley Press, Cambridge, Mass., 1948; "The Specification of Foveal Adaptation," *Journal of Optical Society of America*, Vol. 33, p. 444 (1943); "Visual Data Applied to Lighting Design," *Journal of Optical Society of America*, Vol. 34, p. 605 (1944); "The Visual Effect of Non-Uniform Surrounds," *J. Opt. Soc. Am.*, Vol. 35, p. 233 (1945); "A Simple Criterion for Quality in Lighting," ILLUMINATING ENGINEERING, Vol. XLII, p. 325 (1947).

(Abstract of I.E.S. 1953 Conference Paper No. 6)

Interflection Tables from Conventional Photometric Data

L. E. Innis

PRESENT DAY calculations of the level of illumination are made through the use of the coefficient of utilization. Since this coefficient is the product of two factors, one the luminaire efficiency and the other the interflectance, and since the former is usually provided by conventional photometry, coefficients of utiiization are easily calculated once interflectance values are known.

A simplified procedure for obtaining the data

AUTHOR: Commercial Engineering Dept., Lighting Division, Sylvania Electric Products Inc., Salem, Mass.

TABLE I.—Interflectance for a ceiling-mounted luminaire having a wide spread distribution. P = 1.0. Coefficients of utilization are obtained by multiplying values given in this table by the luminaire efficiency.

C.I.E. Classification: Direct

Pattern of Distribution Curve { **Upper Hemisphere —** / **Lower Hemisphere #2**

C.I.E. Distribution: Upward — 0
Downward — 100

Mounting Details: $\frac{h_m}{h} = 1$ **(Surface)**

h_r	Ceiling Reflectance 0.80				0.70			0.50		
		Wall Reflectance			Wall Reflectance			Wall Reflectance		
	0.80	0.50	0.30	0.10	0.50	0.30	0.10	0.50	0.30	0.10
FLOOR REFLECTANCE = 0.10										
0	1.087	1.087	1.087	1.087	1.075	1.075	1.075	1.053	1.053	1.053
0.1	1.076	1.010	.977	.946	.996	.967	.938	.973	.948	.923
0.2	1.025	.926	.875	.825	.915	.862	.820	.895	.850	.811
0.3	.988	.849	.780	.722	.838	.773	.719	.814	.759	.712
0.4	.934	.772	.696	.633	.764	.689	.633	.743	.677	.628
0.5	.888	.702	.620	.558	.691	.615	.556	.671	.605	.553
0.6	.841	.642	.553	.496	.628	.549	.492	.611	.543	.489
0.7	.796	.585	.501	.443	.577	.499	.443	.560	.492	.440
0.8	.756	.539	.458	.399	.530	.454	.399	.516	.450	.399
0.9	.719	.495	.419	.367	.488	.417	.365	.477	.413	.365
1.0	.685	.454	.385	.333	.450	.382	.333	.441	.379	.332
FLOOR REFLECTANCE = 0.30										
0	1.316	1.316	1.316	1.316	1.266	1.266	1.266	1.176	1.176	1.176
0.1	1.262	1.171	1.116	1.070	1.129	1.086	1.043	1.063	1.027	.994
0.2	1.192	1.035	.960	.890	1.007	.940	.880	.957	.897	.852
0.3	1.131	.913	.838	.764	.907	.822	.752	.863	.785	.737
0.4	1.053	.824	.733	.661	.816	.723	.651	.778	.696	.642
0.5	.996	.748	.646	.574	.731	.638	.571	.705	.623	.563
0.6	.930	.673	.572	.507	.662	.570	.506	.635	.559	.502
0.7	.874	.613	.517	.450	.602	.511	.448	.578	.502	.445
0.8	.827	.554	.469	.403	.546	.463	.401	.534	.457	.399
0.9	.784	.509	.428	.366	.502	.424	.365	.492	.419	.365
1.0	.743	.471	.391	.335	.466	.389	.335	.452	.384	.333

necessary for the calculation of interflectance for several typical distribution curves has been described by Moon and Spencer.[1] Making use of these data, the paper presents tables of interflectance for two very common distributions, both circular in shape. For one of these patterns which is typical of a direct industrial luminaire all flux is directed downward. For the other pattern all flux is directed upward as with a totally indirect fixture.

Through the use of a parameter, *P*, which is equal to the downward component as given in the conventional C.I.E. distribution, these two major distributions have been combined to provide interflectance tables for luminaires of the semi-direct, direct-indirect and semi-indirect types. In all, 15 tables are given of which Table I, applicable to a ceiling mounted industrial luminaire, is typical.

Variations in interflectance for values of *P* ranging from 1.0 to 0.0 are shown in Fig. 1 for a given suspension length and a given set of room surface reflectance values.

Values of interflectance as given in the paper are compared with those obtained by the older, more rigorous and time consuming methods. Agreement is found to be well within the limits required for practical engineering usage.

The effect of variation in suspension length, allowable deviation from the idealized candlepower distribution curve and the possibility of eventually extending the procedure to more concentrating types of distributions are reviewed.

1. Moon, Parry, and Spencer, D. E.: "Interflectance Calculations for Various Luminaires," *J. Franklin Institute*, 252, p. 11-31 (1951).

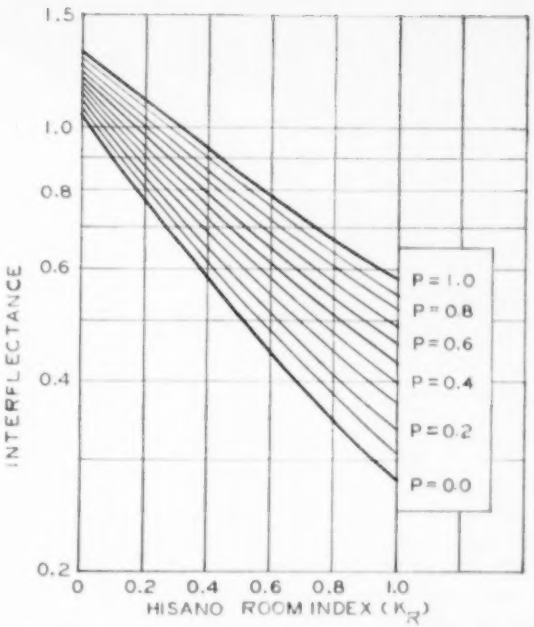


Figure 1. Interflectance curves for eleven different distribution patterns. These curves are obtained by making use of a parameter, *P*, to combine two major distributions, direct and indirect. *P* is defined as the downward component as given in the usual C.I.E. distribution. Values are shown for the case where wall reflectance = 0.50, ceiling reflectance = 0.80, and floor reflectance = 0.30.

(Abstract of I.E.S. 1953 Conference Paper No. 9. Just prior to press-time this paper was transferred to the session on Utilization.)

Efficiency and Appearance Factors In Luminous Panels

THE PURPOSE of this paper is to provide lighting designers with new data showing the effect of varying the spacing relationships of fluorescent lamps and the transmission characteristics of the diffusing medium on the efficiency and appearance of luminous elements.

Complete uniformity is defined as providing optimum appearance and on that basis a relationship between brightness level and maximum non-objectionable contrast is obtained resulting in three

AUTHOR: Commercial Engineering Department, Lamp Division, Westinghouse Electric Corp., Bloomfield, N. J.

M. E. Haskins, Jr.

TABLE I.—Tabulation of Results.

h in.	S in.	Transmission %	Efficiency %	B avg. Ft-L	Contrast	Zone (Fig. 1)	h in.	S in.	Transmission %	Efficiency %	B avg. Ft-L	Contrast	Zone (Fig. 1)
4.5	3	50	62.5	1139	.218	A	9	3	50	60.3	1098	.222	A
		60	67.5	1231	.243	B			60	63.2	1150	.224	A
		70	72.1	1341	.256	C			70	65.6	1197	.219	A
		80	73.8	1347	.278	D			80	67.2	1224	.228	B
	4.5	50	66.2	800	.263	C		6	50	64.4	588	.211	A
		60	70	859	.284	D			60	68.4	624	.270	C
		70	74.8	909	.314	D			70	69.9	637	.264	C
		80	78.8	959	.333	D			80	75.1	685	.279	D
	6	50	69.4	630	.272	C		9	50	70.3	426	.188	A
		60	73.6	672	.297	D			60	72.3	438	.285	D
		70	77.7	707	.327	D			70	72.4	440	.296	D
		80	83.7	764	.346	D			80	74.8	454	.298	D
	9	50	75.2	457	.280	D		13.5	50	73.2	333	.246	B
		60	80.3	488	.295	D			60	76.2	346	.327	D
		70	80.9	492	.342	D			70	76.7	349	.336	D
		80	83	505	.372	D			80	80.3	366	.369	D
6	3	50	63.6	1160	.193	A	12	18	50	70.7	214	.313	D
		60	68.2	1242	.202	A			60	73.5	223	.385	D
		70	69.3	1263	.239	B			70	74.3	225	.436	D
		80	74.7	1363	.235	B			80	77.9	236	.471	D
	6	50	50	638	.232	B	18	6	50	55.2	503	.213	A
		60	74.4	677	.275	C			60	61.3	560	.221	A
		70	76.8	698	.288	D			70	61.9	565	.207	A
		80	78.1	711	.305	D			80	67.1	612	.226	B
	9	50	72.8	442	.290	D		9	50	59.4	361	.167	A
		60	78.1	474	.281	D			60	61	370	.176	A
		70	80.5	488	.283	D			70	62.7	380	.250	B
		80	81.4	494	.291	D			80	62.7	381	.302	D
7.5	15	50	76	347	.300	D		18	50	60.2	182	.192	A
		60	79.5	362	.329	D			60	60.5	184	.299	D
		70	80.5	367	.360	D			70	61.2	186	.323	D
		80	83.5	381	.419	D			80	62.2	188	.345	D

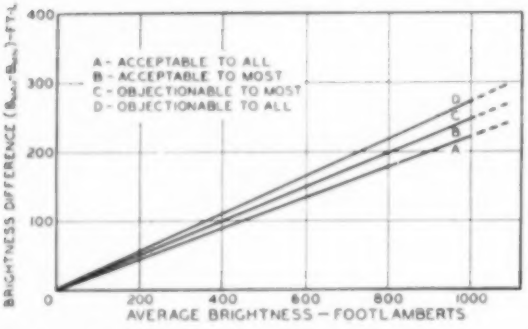


Figure 1. Objectionable brightness differences at various average brightness. The test points gave the center line and fell between the two outside lines.

curves of brightness difference vs. average brightness. These three curves created four zones A, B, C, and D. When the brightness differences between maximum and minimum values fall in area A, the brightness pattern is satisfactory to all observers tested. Area B includes the brightness differences that most observers consider satisfactory but some consider objectionable. Area C includes those brightness differences objectionable to most but not all observers. Brightness differences falling in Area D are considered objectionabe by all the observers tested.

Data are presented on the laboratory results obtained using six variations of lamp-to-plastic distance, five different lamp spacings, and four transmittances. These data show the following:

(1) As the ratio of lamp spacing (s) to lamp-to-plastic distance (h) increases, the lamp spacing for peak efficiency increases from approximately six inches at a ratio of one to approximately fifteen inches at a ratio of two.

(2) The effect of transmittance on efficiency decreases for larger dimensions.

(3) Lower transmittances reach peak efficiency at greater lamp spacings.

The data are then interpreted for appearance using the information first obtained on objectionable contrast. This provides a set of curves showing appearance or acceptability characteristics of different dimensional arrangements.

Table I presents the more significant results.

With the information presented, it is possible to calculate not only illumination and brightness levels but also, a fairly good appraisal of appearance. One word of caution — diffusion is not synonymous with transmittance although the two are usually closely related in most commonly used material. This means that the given information will not hold rigorously for all materials but will be a close approximation and useful to designers as a reference.

(Abstract of I.E.S. 1953 Conference Paper No. 12)

Photographing Fluorescent Lighting Installations in Color

Willard Allphin

THE LIGHTING engineer needs a technique for photographing, or directing the photography of, fluorescent lighting installations in color. Definite filter recommendations for each of the seven fluorescent "white" colors have not been available from film manufacturers, for one reason because they feel that lamp colors have not been completely standardized within the industry. Actually, the colors have been standardized, but the specification limits are not as close as would be considered ideal from a standpoint of color photography.

However, the rendition of a lighting installation does not require the precise accuracy which would be needed in a scientific laboratory. Neither does it requires the exact rendition of colors which would be necessary for photographing a work of art.

The lighting engineer can feel satisfied if the reproduction presents the scene in approximately its original colors, and if it gives a feeling of naturalness to those viewing it. In fact, the usual circumstances of viewing the finished result seldom give an opportunity for comparison with the original.

A test chart consisting of color strips, a gray test card and a white test card was photographed under the seven fluorescent white colors and with various filter combinations. The best slide in each case was selected under standardized viewing conditions.

Final results are incorporated as recommendations in Tables I, II and III. Of course, the wily photographer will take one or two additional photographs giving longer exposures than are called for by the meter. "Bracketing the shots" would also call for a shorter exposure as well as a longer one, but this is unlikely to be needed in photographing lighting installations, since the room must look "well-lighted" even though the luminaires are over-exposed. In fact, one rule of thumb when photographing interiors in color is "when in doubt, give more exposure." Also, while reading from a gray test card is good standardized procedure, it is well to correct for surroundings unusually light or unusually dark in tone.

The results in Table I are based on a large number of experimental exposures, varying filters and exposure time. They are offered as a working tool for photographers who photograph fluorescent lighting installations under the usual demands of the situation. Tables II and III are based on less data, a small number of variations from Table I having been tested for the additional film emulsions. Photographers are advised to put less reliance in Tables II and III and to experiment with variations when necessary.

Table I should serve most of the practical needs for the present, since most color slides of lighting

AUTHOR: Sylvania Electric Products, Inc., Salem, Mass.

TABLE I.—Filter Recommendations—35 mm Kodachrome Film.

	DAYLIGHT FILM		TYPE A FILM		
Lamp	Filters	Extra Stops	Filters	Extra Stops	Preferred Film Compared To Other
Daylight	None	0	*CC–40R+CC–50Y	3	Better
Cool White	*None	0	CC–40R+CC–20Y	1½	Better
Deluxe Cool White	*CC–20B+CC–20C	1½	None	0	Slightly better
White	*None	0	*CC–30R+CC–05Y	½	Equal
Warm White	CC–50B+CC–20M+CC–30C	2	*None	0	Much better
Deluxe Warm White	CC–50B+CC–50C	3	*None	0	Slightly better
Soft White	CC–40C+CC–10B	1	*None	1	Slightly better

*Preferred film.
Filter No. 85 may be used on Type A Kodachrome with the Daylight and Cool White with results practically as good as those indicated in Table I. No. 85 is the filter commonly used when using Type A Kodachrome in daylight.

TABLE II (Tentative).—Filter Recommendations—35 mm Anscocolor Film.

Lamp	DAYLIGHT FILM Filters	Extra Stops	TYPE A FILM Filters	Extra Stops	Preferred Film Compared To Other
Daylight	None	0	*CC–40R+CC–50Y	3	Better
Cool White	*None	0	CC–40R+CC–20Y	2/3	Better
Deluxe Cool White	*None	0	CC–20R+CC–40Y	2/3	Slightly better
White	*None	0	CC–30R+CC–05Y	1	Better
Warm White	CC–20B+CC–10C	2/3	*None	0	Better
Deluxe Warm White	CC–20B+CC–20C	1 1/3	*None	0	Slightly better
Soft White	None	0	*CC–50Y+CC–10Y	1	Better

*Preferred film.

TABLE III (Tentative).—Filter Recommendations—Ektachrome Sheet Film.

Lamp	DAYLIGHT FILM Filters	Extra Stops	TYPE B FILM Filters	Extra Stops	Film Compared Preferred To Other
Daylight	*None	0	*CC–40R+CC–50Y	3	Equal
Cool White	*None	0	CC–40R+CC–20Y	2/3	Better
Deluxe Cool White	*CC–20B+CC–20C	1	*CC–40R	2/3	Equal
White	CC–50B	2	*CC–30R+CC–05Y	2 1/3	Better
Warm White	CC–20B+CC–10C	2/3	*None	0	Better
Deluxe Warm White	*CC–50B+CC–50C	1 1/3	None	0	Better
Soft White	*CC–10B+CC–40C	1	None	0	Better

*Preferred film.

installations are made on 35 mm film and since the film covered in Table I is used almost universally in 35 mm stereo work.

The tables are based on film manufacturers' speed ratings and readings of reflected light from a gray test card of 18 per cent reflectance. Filters are Kodak Color Compensating type. Extra stops represent increased exposure over basic recommendation.

(Abstract of I.E.S. 1953 Conference Paper No. 23)

For Discussion of I.E.S. Conference Papers

To submit discussion on any of the technical papers, presented at the I.E.S. 1953 National Technical Conference, for publication with the paper in ILLUMINATING ENGINEERING—

Send: Three copies to the discussion Organizer for the session (Discussion Organizers are listed below).

One copy to L. E. Barbrow, Co-Chairman, Papers Committee, at National Bureau of Standards, U. S. Department of Commerce, Washington 25, D. C.

One copy to the author of the paper.

One copy (original) to Miss Ruby Redford, Editor, ILLUMINATING ENGINEERING, 1860 Broadway, New York 23, N. Y.

Discussion Organizers

Sources and Controls — E. H. Raddin, Champion Lamp Works, 600 Broad Street, Lynn, Mass. (Papers 1, 2, 3, 4, 5)

Lighting Evaluation — Lt. Cmdr. Dean Farnsworth, U. S. Naval Submarine Base, Medical Research Laboratories, Box 45, New London, Conn. (Papers 6, 7, 12, 15, 23)

Utilization — D. M. Finch, University of California, Berkeley, Calif. (Papers 9, 13, 14, 24)

Street Lighting — F. D. Wyatt, Chicago Park District, 425 East 14th Blvd., Chicago, Ill. (Papers 16, 17, 18, 19, 20)

Measurements — Willard Allphin, Sylvania Electric Products, Inc., 60 Boston Street, Salem, Mass. (Papers 21, 22, 25, 26)

Daylighting — R. A. Miller, Pittsburgh Plate Glass Co., 220 Grant Bldg., Grant Street, Pittsburgh, Pa. (Papers 27, 28, 29)

Calculating Sound-Absorbing Effect of Acoustical Baffles in Lighting Systems

By ERIC H. CHURCH

ON FIRST thought, the subject of acoustics would seem out of place in the Journal of the Illuminating Engineering Society. However, the prevalence of acoustical baffles as an integral part of several modern lighting systems makes it necessary these days for the illuminating engineer to understand this relatively new media in our industry. Prevailing uses of sound-absorbing materials in lighting systems are, of course, as vertical baffles for shielding (as well as for sound-absorption) in so-called grid systems[1,2] and luminous ceiling systems.[3] (Figs. 1 and 2).

Why Acoustical Baffles?

Where it is desired to provide acoustical treatment in a room employing a luminous ceiling system of lighting, it is obvious that to obtain acoustical treatment, the sound absorbing material must be either installed on the walls or vertically from the ceiling. In many areas, covering the walls with sound absorbing material is not feasible. It is in these circumstances, therefore, that combining acoustical baffles with the lighting system is of particular interest. With a luminous ceiling system, the choice becomes one of determining the necessity of acoustical treatment and if so, how much sound absorbing material is required.

With a grid system of lighting, the illuminating engineer has the choice of recommending a translucent plastic baffle, an opaque baffle, or an opaque acoustical baffle. The justification of the choice depends on simple economics. If the ceiling, for example, is covered with acoustical tile and the acoustics are satisfactory, it may be advisable to use a translucent baffle for shielding the lighting system and gain approximately 10 per cent in light. If the ceiling is in a bad condition and the addition of acoustical tile saves a replastering job, the translucent baffle again might well be considered. However, when acoustical treatment is desired and where the plastered ceiling has a satisfactory appearance, the sound absorbing baffle will provide both shielding and acoustical treatment.

A paper presented at the East Central Regional Conference of I.E.S., Baltimore, Maryland, May 14-15, 1953. AUTHOR: In charge of Laboratory, Benjamin Electric Mfg. Company, Des Plaines, Ill.

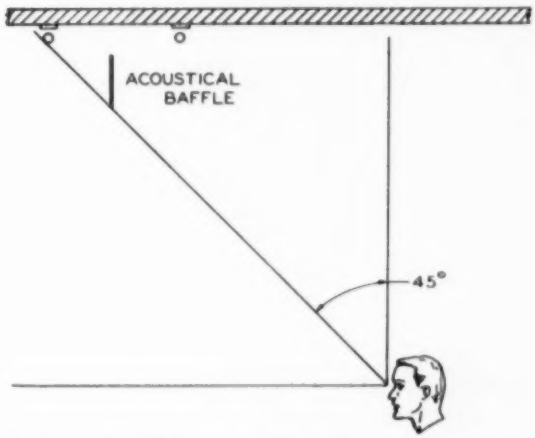


Figure 1. Mechanics of a grid system with 45-degree shielding.

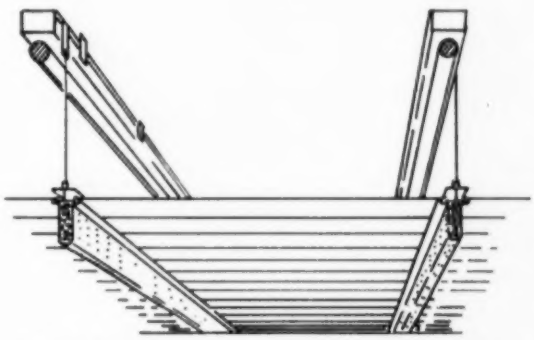


Figure 2. Mechanics of translucent ceiling system.

How Much Acoustical Treatment?

The calculations and predications of acoustics is an exact science and some familiarity with acoustical measurements and terms is helpful if the lighting engineer or salesman is to explain to the user the justification of acoustical shields. Where treatment of a room with acoustical baffles is considered, there should be two objectives in mind:

1. To reduce the noise level in the area.
2. To reduce the reverberation time.

Sound, as referred to in this discussion, is a disturbance of air pressure that can be detected as an

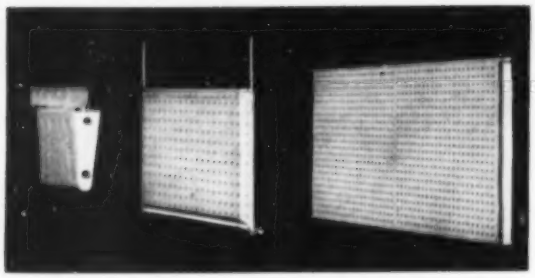


Figure 3. Three types of acoustical baffles.

SOURCE OR DESCRIPTION OF NOISE	NOISE LEVEL IN DECIBELS
THRESHOLD OF PAIN	130
FACTORY	78
ORDINARY CONVERSATION 3 FT.	65
MEDIUM STORE	62
RESIDENTIAL STREET	58
SMALL STORE	52
HOUSE, LARGE CITY	40
HOUSE, COUNTRY	30
AVERAGE WHISPER 4 FT.	20
RUSTLE OF LEAVES IN GENTLE BREEZE	10
THRESHOLD OF HEARING	0

Figure 4. Decibel values of common noises.

Figure 5. How the sound level is computed when adding two random noises.

auditory sensation by the human ear. It can roughly be broken down into three classifications: music, speech, and noise. Generally speaking, noise may be considered as an unwanted sound. The difference between noise, music and speech can be quite arbitrary. For example, a pleasing musical score could be extremely annoying when a telephone conversation is involved.

Sound is measured and expressed in terms of pressure. The unit of measurement is called a decibel, often abbreviated "db." Because of the great numerical differences in the types of sound—for example, the noise in a punch press department is many times that of a falling leaf—sound pressure is expressed in a logarithmic scale. One decibel is the lowest sound that can be detected by the human ear. Because the decibel is a logarithmic function it cannot be added arithmetically. For example, two signals producing 30 decibels each would not produce 60 decibels if they were both actuated together.

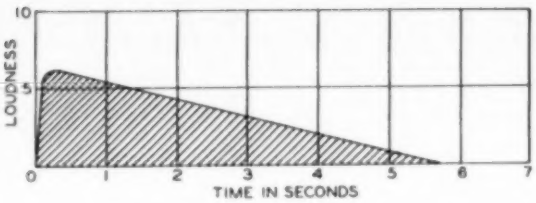


Figure 6. Decay time of a spoken word.

When two random noises are combined, a chart similar to that shown in Fig. 5 can be used to compute the noise level. If D is their difference in decibels, N is added to the higher level to obtain the total level. For example, adding 50 and 40 decibels would give 50.4 decibels. When two equal noise levels are added, the difference is 3 and therefore the decibel level is increased by 3.

Sound waves striking the walls, ceiling and floor of a room are reflected back and forth until their energy is finally dissipated. This movement of the sound waves in an enclosed room is known as *reverberation* and the phenomena has considerable influence on speech and music. For example, sound pressure readings in decibels are considerably higher in an enclosed area, such as a room, than they would be in an open field. Therefore in a room where relatively weak sound sources are objectionable, reverberation will contribute to the source of the sound, thus helping to make it audible. However, too much reverberation is probably the most serious acoustical defect experienced and is much more so where the walls and ceiling are finished with hard non-porous plaster. This condition permits the sound to reflect back and forth many times, absorbing very little of its energy. Each sound, instead of dying out quickly, persists for some time, so that spoken words blend with their predecessors and set up a mixture of words that produces confusion.

It has been found that the average person can emit words at the rate of about .3 of a second. In certain rooms it may take about 5.8 seconds for the sound of a word to die out. It can readily be seen that sound traveling at the rate of 1120 feet per second would soon reflect off a wall and cause overlapping of each spoken word.

Because reverberation is such an important function of acoustics in a room, a standard of measure

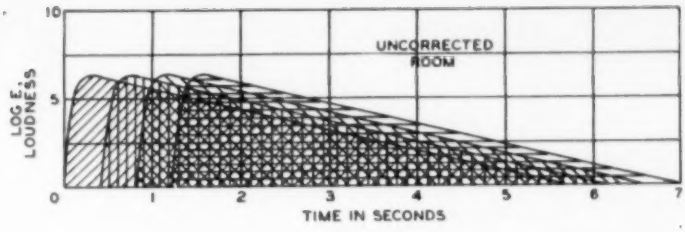


Figure 7. Diagram showing the overlap of four words in a speech in a reverberant room (Watson).

called reverberation time has been established and it is found by the Sabine equation

$$t = \frac{0.05\,V}{A8}$$

in which V is the volume of the room in feet and $A8$ is the total absorption of the room. Experimental work completed by acoustical physicists has established the optimal time of reverberation for most room conditions. For example, in a room 200 feet by 100 feet, the optimal reverberation time would be 1.25 seconds.

Sound can, of course, be transmitted through the walls of a room. This noise is reduced very little by sound-absorptive treatment. Acoustical materials are not a cure for poor sound insulation. However, the sound generated in a room can be somewhat controlled and if, for example, the noise level is reduced 3 decibels, the sound level of speech can also be reduced 3 decibels which means the acoustical power expended in speaking can be halved. The amount of noise reduction in a given room is found by the formula

$$NR = 10 \log_{10} \frac{a \text{ "after"}}{a \text{ "before"}} = db$$

NR = the noise reduction, a "before" = the room before acoustical treatment, and a "after" = the room after acoustical treatment.

Control of reverberation and sound reduction is accomplished by the use of sound absorption materials. This includes prefabricated panels, acoustical plaster and various glass and fibre packings. All materials have some acoustical absorption properties, including the human occupants of a room. As can be expected, the materials used to treat a room are those that have the quality to absorb sound and turn it into other forms of energy such as heat. The materials that produce this phenomena depend on the porosity of the material in which the sound waves can propagate themselves into the pores of the material where the energy is converted. If a material is thick enough and porous enough, 90 per cent of the energy of an incidental sound wave can be absorbed. Materials that are used for acoustical treatment are rated by the effectiveness of a material to absorb sound. If a sound wave strikes a material and 60 per cent of it is absorbed with the rest of the sound reflected, the absorption coefficient of the material would be 0.60. This probably sounds familiar to you — it is very much like light reflection factors. Each square foot of this material is the absorptive equivalent of 0.60 square feet of a perfectly absorptive surface. The sound absorption of a material is then expressed in a unit called sabins. A great many materials have been tested and the sound absorption coefficients of the materials are known and can be found in either acoustical handbooks or from material manufacturers.

When the sound absorption coefficient is known it is relatively simple to calculate the sound absorption units or sabins.

In order to illustrate the method of calculating acoustical properties, let us assume a typical classroom 24 feet wide by 32 feet long and 12 feet high. The ceiling and walls are finished of gypsum plaster and for simplicity, the windows and doors are ignored. The floor is finished with linoleum tile on a concrete floor. The room contains 30 desks with an absorption coefficient of .42 per desk or 4.2 per pupil and desk. By referring to an acoustical handbook it is found that the absorption coefficient of the plastered walls and ceiling is .04 and that of the floor .03.

The total absorption in the room, not occupied, is as follows:

Ceiling $24 \times 32 \times .04$	31 sabin units
2 Walls $24 \times 12 \times .04 \times 2$	23 sabin units
2 Walls $32 \times 12 \times .04 \times 2$	31 sabin units
Floor $24 \times 32 \times .03$	23 sabin units
30 desks at .42 per desk	13 sabin units
Total	121 sabin units

Total sabin units occupied —

$$121 + 113 = 234 \text{ sabin units}$$

Reverberation time — room unoccupied —

$$t = \frac{.05\,V}{121} = \frac{.05 \times 9216}{121} = \frac{461}{121} = 3.8 \text{ sec.}$$

Reverberation time — room occupied —

$$t = \frac{.05\,V}{A8} = \frac{.05 \times 9216}{234} = 1.9 \text{ sec.}$$

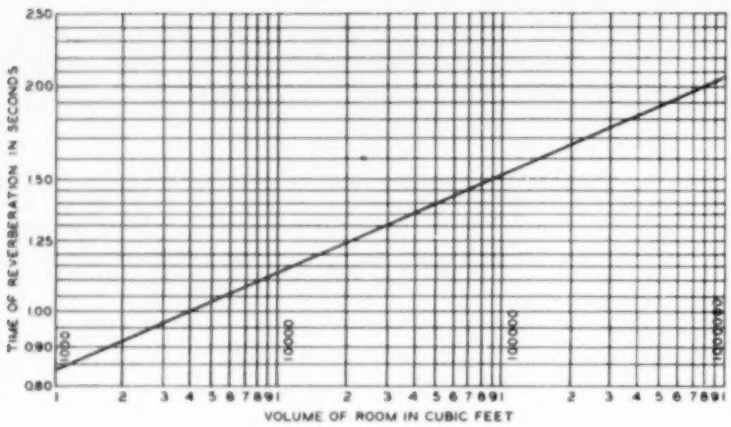


Figure 8. Optimal time of reverberation (Watson).

It can be seen from Fig. 8 that the optimal time of reverberation should be 1.10 seconds. In view of this, let us assume it was decided to cement acoustical tile on the ceiling. The following results would be obtained:

Absorption of acoustical tile .51	
Ceiling $24 \times 32 \times .51$	
minus $23 \times 32 \times .04$	392 sabin units
2 Walls $24 \times 12 \times .04 \times 2$	23 sabin units
2 Walls $32 \times 12 \times .04 \times 2$	31 sabin units
Floor $24 \times 32 \times .03$	23 sabin units
30 desks at .42 per desk	13 sabin units
Total	482 sabin units

Total sabin units, room occupied—

$$482 \text{ plus } 113 = 595$$

Reverberation time, room unoccupied—

$$\frac{.05\,V}{AS} = \frac{.05 \times 9216}{482} = .95 \text{ sec.}$$

Reverberation time—room occupied—

$$\frac{.05\,V}{AS} = \frac{.05 \times 9216}{595} = .8 \text{ sec.}$$

The minimum reverberation time for a typical classroom as described should be .75 sec. with maximum 1.10. It can be seen from the calculations that the treatment is satisfactory.

The noise reduction of the room from the treatment is found from formula

$$NR = 10 \log_{10} \frac{a \text{ "after"}}{a \text{ "before"}}$$

in which the sound absorption units before treatment are 234 sabin units and 595 sabin units after treatment. Therefore the noise reduction is

$$NR = 10 \log_{10} \frac{595}{234} = 10 \log 2.54 = 4 \text{ db.}$$

As stated, many materials and the method of mounting materials have been tested to obtain the respective sound absorption coefficient. However, the advent of acoustical baffles as light shields provided a new set of problems. The spacing of the baffles, the distance from the ceiling and the width of the baffle itself all had to be tested and taken into consideration. In order to obtain certain basic information, several materials used as baffles were measured at fixed spacings to obtain relative comparisons. These tests were conducted under the supervision of Dr. Paul H. Geiger of the University of Michigan.

Fig. 10 shows the reverberation room in which the tests were made. Loudspeakers are fixed on a vane moving radially and a pure tone is generated through the speakers at certain frequency. As the vane moves around, the speakers permit the sound to "saturate" the room. A complicated set of instruments turn the sound off and measure the time that the sound takes to decay. The test is repeated at a different number of cycles such as 125 per second, 250 per second, 500 per second, etc. Tests are first conducted in a bare room and then with the objects to be tested mounted on the floor. The difference between the two tests gives the data for the sound absorption of the material from which the coefficient of sound absorption is derived.

Baffles were made up of materials consisting of acoustical perforated material 1 inch thick by 12 inches wide by 8 feet long; 1 inch thick by 9½ inches wide by 8 feet long; translucent plastic 1 inch thick by 9½ inches wide by 8 feet long; and

MATERIAL	THICKNESS INCHES	ABSORPTION COEFFICIENTS 128 CYCLES	256 CYCLES	512 CYCLES	1024 CYCLES	2048 CYCLES	4096 CYCLES	AUTHORITY
BRICK WALL, PAINTED	18	01	01	02	02	02	02	7

Figure 9. Typical form for sound absorption coefficients.

perforated metal enclosing fiber glass 9½ inches wide by 1 inch thick by 8 feet long. Four of each of these baffles were mounted on the floor and on two-foot centers. The distance from the floor to the top of the baffle was 6¾ inches, which is the same as found in a grid lighting assembly. The tests gave the following results:

Sound Absorption
Frequency C.P.S.

Material	125	250	500	1000	2000	4000	NRC
12" wide perforated acoustical tile	2.6	4.0	7.8	13.9	15.3	19.0	10.2
9-12" wide perforated acoustical tile	2.0	2.8	6.0	11.4	13.3	16.3	8.4
Translucent plastic	1.3	0.6	0.6	1.7	3.2	6.1	1.5
Baffle consisting of perforated metal enclosing fiber glass	2.4	6.2	9.2	17.0	18.7	12.8	12.8

All Samples 1 inch thick on special mountings.

Mounting: Samples 9.5 inches wide were hung vertically spaced out 6.75 inches from room surface.
Samples spaced 24 inches.

The absorption values given above are sabins per 16-foot long shield.

The results obtained from this test show that the perforated metal acoustical baffle has the most efficient sound absorption qualities and also the highest noise reduction coefficient. If the baffles tested were placed on different centers or more baffles in a given area were used, it can be readily seen that different results would be obtained. This statement is an important one to keep in mind when appraising the acoustical values of lighting systems using acoustical baffles.

In the sample room previously discussed it was shown that the unoccupied room not treated had a total absorption factor of 121 sabin units. The reverberation time was found to be 3.8 seconds, which is too long for efficient classroom acoustics. If the ceiling were treated with acoustical tile, which may have been necessitated by both the desire for an acoustical treatment and to cover an unsightly ceiling, the reverberation time would have been .95 sec., a satisfactory acoustical condition. With this ceiling treatment, acoustical baffles would not be required, and 10 per cent more light could be obtained by using translucent baffles.

Where the reverberation time is 3.8 sec. the following calculation can determine if the metal clad acoustical baffles are justified:

Previous Room, unoccupied, has total of 121 sabin units. A grid lighting system is to be installed with a sound absorbing coefficient of .40.

$$\text{Grid Area } 30 \times 16 = 480 \text{ sq. ft.}$$

$$\text{Total Sabins} — 480 \times .40 = 192.0$$

$$\text{Total Sabins in Room} — 192 + 121 = 313$$

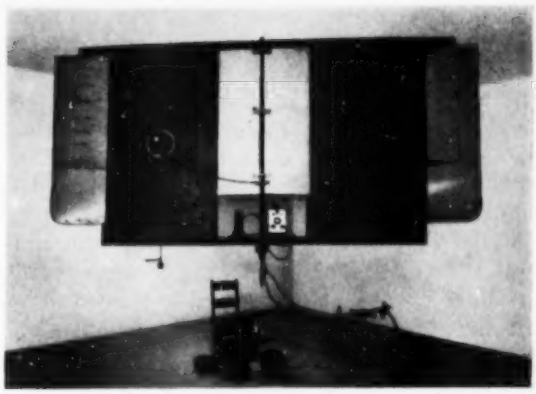


Figure 10. Reverberation room used in tests.

Reverberation time —

$$\frac{.05\,V}{AS} = \frac{.05 \times 9216}{313} = 1.4 \text{ sec.}$$

Reverberation time with 30 people and desks —

$$\frac{.05\,V}{AS} = \frac{.05 \times 9216}{439} = 1 \text{ sec.}$$

The reverberation time has been reduced to an acceptable limit by the addition of the baffles.

The noise reduction is found by the following calculations:

$$10 \log \frac{439}{205} = 10 \log 2.141 = 3.3 \text{ db.}$$

This also indicates that the metal clad acoustical baffles are justified and that 10 per cent of the light may be sacrificed for the beneficial acoustical results.

The calculation of the acoustical effect of using baffles under luminous ceilings is similar to that described. To determine the baffling necessary, calculations can be made from tables similar to this.

Description of Material

Test No.	Material
A51-108	Luminous ceiling assembly consisting of corrugated plastic spaced 10" from solid backing with 6" deep acoustical baffles spaced 3' on centers. Assembly tested consisted of 72 square foot area with three baffles 8' long.

Results of Test

Test No.	Material							
A51-108	Luminous Ceiling							
	Mounting	128	256	512	1024	2048	4096	Noise
	#7	.18	.32	.28	.35	.62	.49	.40

At the present time there are three types of acoustical baffles supplied with lighting systems.

The one shown on the extreme left of Fig. 3 is used under a completely covered translucent ceiling. The center baffle is the metal clad type used for grid light systems and the one on the right is the perforated acoustical tile also used for grid lighting systems. Each of these baffles is similar in effective sound absorption. However, different design gives each certain advantages. For example, the steel clad baffle is, first of all, fire resistant. With this type also, the panels can be taken apart, lifted out and the interior cleaned or painted without destroying any of the sound absorption value. The center baffle shown in Fig. 3 is narrower in height. The perforated tile (right) permits a lower brightness but is more difficult to maintain and will support combustion.

Types of Acoustical Materials

Prefabricated acoustical materials in general are rated by Federal specifications and each material is classed for certain characteristics.

The following tables give some of the classifications in the Federal Specification (SS-A-118-a):

Grade	Noise Reduction Coefficient	Grade	Noise Reduction Coefficient
1	0.90 or over	7	0.60
2	0.85	8	0.55
3	0.80	9	0.50
4	0.75	10	0.45
5	0.70	11	0.40
6	0.65	12	0.35

1. Incombustible Material . . . no flame shall issue from the specimen during or after flame application. Glow shall not progress beyond the fire exposed area.
2. Fire-Retardant Material . . . no sustained flaming shall issue from the specimen. Any flame which occurs shall be limited to intermittent short flames from the area directly exposed to the test flame . . . no flaming shall occur more than two minutes after the test flame is discontinued.
3. Slow-Burning Material . . . all flaming shall cease within five minutes after the test flame is discontinued.
4. Combustible Material . . . material not conforming to any of the above requirements.

Acoustical materials are also classified according to types.

Type I. Cast units having a pitted or granular-appearing surface.

- Class A. All-mineral units composed of small granules or finely divided particles with portland cement binder.
- Class B. All-mineral units composed of small granules or finely divided particles with lime or gypsum binder.
- Class C. Units composed of small granules or finely divided particles of mineral or vegetable origin with incombustible mineral binder.

Type II. Units having mechanically perforated surface; the perforations to be arranged in a regular pattern.

- Class A. Units having a perforated surface which acts as a covering and support for the sound absorbent material. The facing material to be strong and durable and substantially rigid.
- Class B. Units having circular perforations extending into the sound absorbent material.
- Class C. Units having slots or grooves extending into the sound absorbent material.

Type III. Units having a fissured surface.

Type IV. Units having a felted fiber surface.

- Class A. Units composed of long wood fibers.
- Class B. Units composed of fine felted vegetable fibers or wood pulp.
- Class C. Units composed of mineral fibers.

It is hoped that this discussion will aid the illuminating engineer who may wish to calculate the sound-absorbing effect in the use of acoustical baffles. It is certainly obvious, when used both in correct quantity and in proper application, such a media can be both functionally and economically sound.

References

1. Benson, B. S., Jr., and Church, Eric: "Grid Systems for Classroom Lighting," ILLUMINATING ENGINEERING, Vol. XLVII, No. 1 (January 1952).
2. Foulks, William; Gilleard, George, and Weibel, William: "Classroom Designed for Light and Sound Control," ILLUMINATING ENGINEERING, Vol. XLVII, No. 1 (January 1952).
3. Parsons, J. F.: "Luminous Ceilings," ILLUMINATING ENGINEERING, Vol. XLV, No. 5 (May 1950).
4. Knudsen, V. O., and Harris, C. M.: *Acoustical Designing in Architecture*. John Wiley and Sons, Inc., 1950.
5. Watson, F. R.: *Sound—An Elementary Textbook on the Science of Sound and the Phenomena of Hearing*. John Wiley & Sons, Inc., 1935.
6. Olson, H. F.: *Elements of Acoustical Engineering*. D. Van Nostrand Co., Inc., 1940.
7. Miller, K. B.: *Telephone Theory and Practice*, Vol. I, McGraw-Hill Book Co., Inc., 1930.
8. The F. W. Wakefield Brass Company, Vermilion, Ohio.
9. Curtis Lighting, Inc., 6135 W. 65th Street, Chicago, Illinois.
10. Luminous Ceilings, Inc., 2500 W. North Avenue, Chicago, Illinois.

[EDITOR'S NOTE: This article is one of a series on the characteristics of materials and services relating to the lighting industry. Previous articles in this series are: "Characteristics of Plastics," December 1951; "Characteristics of Porcelain Enamel," July 1952; "Characteristics of 300-Degree White Baked Enamel Finishes," February 1953; "Characteristics of Alzak Aluminum," March 1953; "UL — and the Lighting Industry," July 1953; "Tungsten in the Lighting Industry" and "Tungsten — Its Application in Electric Lamps," August 1953. Future articles are planned for glass, distribution, etc.]

Some Answers to the Future Of Illuminating Engineers

By JOHN O. KRAEHENBUEHL

CLASSIFICATION of the following material could be made under editorial material in ILLUMINATING ENGINEERING such as the "Views and Opinions" department. However, it is a report of factual instances and not opinion, with a small part devoted to some suggestions. It is a sequel to a series of articles[1,2,3,4,5] published in IE during the past year or so, by college faculty members and employees of utilities concerning the education, curriculum, professional registration, and employment of illuminating engineers. They were, in general, pessimistic. The following is a report of the experiences encountered by the students and staff teaching a *curriculum* of Illuminating Engineering at the University of Illinois. The word *curriculum* is used advisedly as contrasted to those schools which offer one or two courses, mostly as *options*, to electrical engineers. This curriculum has been reported in ILLUMINATING ENGINEERING.[6] It was established in 1945 and the first graduates received their degrees in February 1948. As of February 1952, 100 students had received degrees specializing in Illuminating Engineering under the curriculum as reported.

Since these graduates form a closely knit group with a special interest it has been possible to follow their activities after graduation. This "follow up" has been stimulated by a yearly letter which brings response from a high percentage of the former students, who in turn usually report on those who do not respond. With the graduation of the one-hundredth student, ninety-four were in illuminating engineering or associated with the lighting industry in some way. Of the six others, two were in power, one in oil, and three in electronics. This will be recognized as a very high percentage of graduating students remaining in a specialized field of study.

Since 1952 the percentage of graduates remaining in the field has been decreasing and now is between 85 and 90 per cent. The probable reason for this shift is, (1) many of the students have been taken into military service and have, because of their electrical engineering training, been placed in electronics, and (2) the electronics industry has made that branch so attractive with financial offers that some interest has shifted to the more lucrative field.

It must be kept in mind that these men have had a thorough basic training in circuits, machines, and electronics, devoting the time usually directed toward specialization in power or electronics, to specializing in Illumination. In following the curriculum they have been introduced to sales, physiology, psychology, and architecture as well as subjects in technical light and illuminating engineering. Stress has been placed upon public speaking and business letter writing. It has been reported that work in speech and business letter writing has contributed more toward promotions than any other part of the curriculum.

In general the graduate has been happy in his work and those who have wished to change have been seeking something better in the illumination field, with no desire to change their general professional activity. Then why the gloom surrounding the training and obtaining of trained personnel in Illuminating Engineering? Probably some of our experiences may explain some underlying causes and suggest some cures.

As has been ably pointed out in a previous paper, the Electrical Engineering Departments are not interested because they are not acquainted with the technical demands of the field. The industry and utilities have themselves to blame for this. Representatives from these interests do not understand the function of the Illuminating Engineer in their organization. It is not unusual for the student to be told by personnel representatives that there is no opportunity for the illuminating engineer and that recruiting in this field is from the high school group. At one time this was true in the instance of one of the larger manufacturers but who now is employing some of our best and the greatest number of our illuminating engineering graduates. The situation was quickly corrected and illuminating engineering students are being interviewed by men from the illumination division. Another manufacturer sends one of his electronics laboratory men to interview students. In this in-

AUTHOR: Professor of Electrical Engineering, University of Illinois, Urbana, Illinois.

stance the individual frankly admits that he does not know what the illuminating engineer does in his company nor what the opportunities are. Other instances of the same type may be given for utilities and distributors. In general the interviewers leave the impression that the profession of illuminating engineering is of no importance in their industry. With this lack of interest and enthusiasm on the part of those who need illuminating engineers and who call upon educational institutions to train and furnish material for development in the profession in their specific activities, it is rather foolish to expect colleges to become interested in the field and for their staff to become active in the profession.

Our students have encountered another rather discouraging practice, for the most part by utilities. A representative will frequently interview a student, indicate the possible advantages in joining his company's lighting group and otherwise show interest in employing the student when he obtains his degree. However, upon employment the student must take a training course lasting from one to two years so that he may have a complete picture of the organization, to develop later for positions in supervision and administration. It is understood that when the course is completed the student will be placed in the illumination division, which is his choice of profession and for which he has taken specific training. In too many instances, however, when his training is complete he is assigned to installation, transmission design or some other division. This might be necessary for a time, if no openings were available in the lighting division. But in the instance of one of the worst offenders in the utility field, while the young illuminating engineers were requesting information on open positions so that they could transfer to the field of their interest, this utility's lighting division was at the same time requesting that the university interest some of its students in their vacancies! In all fairness can anyone expect a faculty to develop the interest of students in a branch of the engineering profession which attempts to supply itself with trained men for its future development by false promises? Utilities have been very negligent in permitting the power options to fall to so low a state that they must supply these phases of their activities by a questionable practice. Personnel departments should understand that whatever practice they follow will soon be known to the students and subjected to an analysis far more critical than any their own organization will ever make.

This citing of some of the experiences of the student with the industry is intended to emphasize the fact that the educator has to meet the same conditions as does the manufacturer of material products. Unless there is a profit market for the product it does not pay to build the product. In our experience industry, in some instances, has not demanded the trained student in its field nor has it always dealt fairly with him. Only when there is a demand for the product and fair practice by the employer can the educational institution obtain the raw material to train in fundamentals which later lead to development of professional men which the young branch of engineering needs so badly.

If Illuminating Engineering is to be a profession the student candidate must be considered in a financial sense along with students entering the other professions. He cannot be obtained at a salary the industry offers the high school graduate. He will have to receive a starting salary of the same order as does the graduate in other professions. Recognition must be given for his additional training and corresponding development as his degree progresses from bachelor of science to master of science on to a doctorate. In the electrical engineering field, at present, the salary levels are set by those specializing in electronics. The war and military developments have in both electronics and aviation, through the cost-plus system, made it profitable to pay high salaries to engineers when competing in a scarce market for these services. Utilities and manufacturers who do not have such contracts must compete in this labor market with nothing more to offer, in lieu of money, than a promised security which war industry cannot give.

An analysis of the student demand in the practicing profession is only one side of the picture for there are definite influences in the educational field which are working against the training of illuminating engineers. This influence begins in the high school science classes. The student has placed before him only the possibilities and future in a career in electrical engineering which deals with electronics. The high school teacher seldom has a broad enough training in applied science to develop his own judgments and very little experience upon which to base an analysis in student guidance. He is influenced mostly by the Sunday supplement type of report concerning the importance of the various branches of engineering. That which exhibits romance, considerable of which can be classified under the gadget field, seems more important than would the everyday practice of supplying power for life's comforts and necessities, and light for health's sake. The prospective engineer receives little guidance toward power or illumination options in electrical engineering.

In the engineering colleges also, there has been

a general policy shift in electrical engineering toward glorifying electronics and depreciating power. Since illuminating engineering has been classified with power, even though this is absurd, it can expect the same treatment and is viewed by the purely theoretical thinkers as a sales and not a technical subject. To date illumination has never had a real place in the engineering college. It can only be said that the same policy and thinking which tends to depreciate the education program in power in no way tends to encourage the addition of illumination to an educational program, which has a tendency to be compressed in to one curriculum, electronics.

Several forces are at work making the growth of this narrow policy possible. The physics departments in colleges tend away from the general science toward nuclear study with the net result that electrical engineering is becoming saturated with physics graduates who do not follow the new policy, for engineering is the only outlet for their training. The engineering field, in particular electrical engineering, was prepared to receive them because the engineering academic policy through the influence exerted by the classics and humanities demanded that higher academic degrees be required in the qualifications of the staff. Engineers had not recognized the necessity of additional academic training but had placed emphasis upon experience in actual practice as a prerequisite to teaching. When the demand for higher degrees for staff and administrators became the policy, those prepared to fill the requirement were those trained in physics where for years higher degrees were necessary and a must for even a minor teaching position.

With these changes electrical engineering education began to depreciate practice, and mathematical and theoretical analysis came to the fore. The practice of electronics could be and was in the hands of the gadget artist, who did not necessarily need technical knowledge. By nature this type of practice could not enter a college curriculum. Those whose training had been in a narrow and theoretical field could not appreciate practice and application of the more complicated nature when dealing with power. Fortunately engineering training, which stresses thinking and analysis, will prepare an intelligent individual for any branch of engineering and any option in any specific engineering division. A well trained individual in an electronics option with proper orientation and on-the-job training will, after a period of time, adjust to either the power or illumination profession, and the reverse is true.

Some schools have reduced their electrical engineering to a single option of electronics and it may be expected that others will follow. With the training and interest of both the major portion of the staff and administration in the electronics field, the tendency toward single curriculum is natural. This tendency will eliminate the power option and certainly will not encourage illumination options in the colleges. The least that all electrical engineering departments could do for the student is give him fundamental courses in both power and illumination so that he would have some basis upon which to decide, when an offer of some advantage was made outside his specialized training. Utilities and other users of electrical engineering talent will in the end have to accept the electronics trained men and convert them through training courses or practice to the recognition of the difference in power and energy concepts. The alternative is either to establish schools which will train their men, or support those schools which do not adopt the narrow policy of eliminating power. If this is not done the power industry will either have to meet or offer higher inducements (the latter the more likely) to obtain superior graduates to retrain for its demands, or be satisfied with ordinary or inferior students rejected by those recruiting electronics students. Whereas the superior individual will prove satisfactory in any field, the average and inferior graduate will be slow and expensive. Those who for the past few years have been able to obtain graduates for the utility and power field have automatically, by their policy, been eliminating themselves from competition for the graduates in the upper class group. Experience has shown that most of the more desirable and talented students have been choosing the electronics option. This has to a great extent come about by the sales practices used by electronics interested staff members and the forces previously listed.

These changes are neither malicious nor premeditated but natural. When electrical engineering was definitely a power option too little attention was given to the growing field of electronics and now the same narrow policy causes a swing in the opposite direction. If the utilities and those interested in machines, power equipment and power transmission wish to meet this encroachment in a way to reach a reasonable balance, they must present a solid front requiring a curriculum meeting their demands and paying a salary which will attract the better men. A policy of complacency on the part of these employers will lead to accepting those electrical engineers who were not acceptable to the electronics industry. The graduate will be not only an individual who must be re-trained

but one with no particular interest in his job and not from the superior group of graduating students. Since illuminating engineering has by practice been associated with the power group the same will apply to this profession.

Up to this point the outlook is pessimistic, an attitude indicated by previous papers on the subject. But this is not necessarily a condition which must be accepted. Both the power and illumination professions must definitely decide what they wish to have developed in their prospective employees. They must also indicate the type of training and the technical material covered. For the power group this means a modernizing of their curriculum, for the illuminating engineering group, a solid curriculum pointing toward a thorough training in the profession, not a course or two tagged on to an existing power option. To continue to associate with the power option is to inherit all its difficulties.

Once the profession recognizes its objective and desires as to a curriculum which will give a fundamental grounding to its future members, it will be necessary to have these wishes recognized by the colleges. Wishful thinking will not do this for at present there is an antagonistic attitude by staff and administration against introducing illuminating engineering and continuing the power option. As in any productive development, two things are needed — raw material and a market.

The raw material must come from the high school graduates. For a time at the University of Illinois a fundamental course in Illumination was given to all electrical engineers in the sophomore year and from this group it was a simple matter to obtain students interested in the Illumination Option. Before the high school student will be interested in any profession he will have to know that it exists. Further, an interest must be built through a knowledge of what the professional man has as his duties and responsibilities and what his security and remuneration will be in the field as well as the possibility of advancement. To supply this information belongs to a program which the profession itself must develop. If a man finds pleasure in his work and has found its practice a joy and satisfaction, it is necessary that this knowledge be transferred to those who may be induced to follow, and develop, the profession when he has retired. The first group to recognize this requirement was the chemical industry. The chemical industry recognized that in the future it must have trained men to run its plants and factories. The Manufacturing Chemists Association, cognizant of the fact that the industry will be able to use from 5000 to 10,000 graduates annually with only 3800 students of chemistry graduating each year, considered it time to do something actively. Their program calls for a plan, outlined in a booklet sent to the members, which suggests intensive and repeated talks at the secondary school level, tours through chemical plants, scholarships and guidance available to the students who express their interest in chemistry as a career. If this becomes a professionally guided program intensively followed by those in each community, not merely talks are given (usually by some of questionable ability) where a personal interest is shown in the young prospects, other branches of engineering can expect to see chemistry get its full quota, while there will be fewer left for the other professional fields. It would be well for the Illuminating Engineering Society to formulate its plan and start its program so as to assure itself that professional personnel demands will be met in the coming years when the market for engineers will be much tighter than it is today, if present indications mean anything. Productive capacity in industry has increased three and four times, with the output of engineers doubling since 1940. On the other hand, all indications at present point to a decrease of graduates for a few years.

With a demand from the entering student for specific professional training, forces will be active to demand from the college an opportunity to obtain the training. If some schools fail to recognize demand, those prepared and the more progressive will enroll the students. With the raw material available and pressure exerted at the college entrance level, complete capitulation can be obtained by the action of the employer, for if he will accept only men trained in the specialized profession and offer financial remuneration superior to the other professions, he can be assured that the pressure will increase for such curricula, and that an increasing number of superior students will consider the illuminating engineering profession as a career.

The problem is one that industry should have little difficulty comprehending. To merchandise a product it is common practice to advertise, build a superior product and obtain a market. In developing the profession the Society probably has the task of "advertising" and it has in many communities, interested trained individuals who could present illuminating engineering as a career to high school and grade school students and who could arrange to demonstrate its practice in local communities. The employer: utilities, lamp and fixture manufacturers, distributors, architectural firms and consultants will have to offer specific activity in the illuminating engineering profession comparable to that in any other and if it is desired to attract superior individuals, they must offer

something better than the average. The first step of converting the raw material to a graduate in the profession belongs to the engineering college or as some suggest, to the fine and applied arts school, using the engineering college for technical service courses. This function can and will be assumed by the colleges when there is a demand, for in the past schools have given a reasonable account of themselves in preparing thousands of young people for professional careers. The final maturing of the individual to the height of his ability in a profession again belongs to the Society which through its activities and the use of section and chapter meetings, national and regional conferences and through its publications, supplements the experience of the individual as he practices his profession. The Society has as a function the development of the profession through the requirement of a high standard of ethics, and protection of the profession through advocating and promoting a professional licensing system that will assure a high standard and protection to those who must devote years of study and practice toward their professional development.

References

1. Timoshenko, G. S.: "Basic Education in Illuminating Engineering." Views and Opinions, ILLUMINATING ENGINEERING, Vol. XLVII, p. 295 (June 1952).

2. Stedman, J. M.: "Opportunity Unlimited . . . For Illuminating Engineers," Views and Opinions, ILLUMINATING ENGINEERING, Vol. XLVII, p. 528 (October 1952).

3. Abramowitz, A.: "Illumination Courses in U. S. and Canadian Colleges." It Seems to Me, ILLUMINATING ENGINEERING, Vol. XLVII, p. 12A (November 1952).

4. Kammerer, G. M.: "Illuminating Engineers — Orphans of the Industry." Views and Opinions, ILLUMINATING ENGINEERING, Vol. XLVIII, p. 1 (January 1953).

5. See also, Letters to the Editor, in ILLUMINATING ENGINEERING.

6. Kraehenbuehl, John O.: "Education and the Professional Engineer." ILLUMINATING ENGINEERING, Vol. XLIV, p. 596 (October 1949).

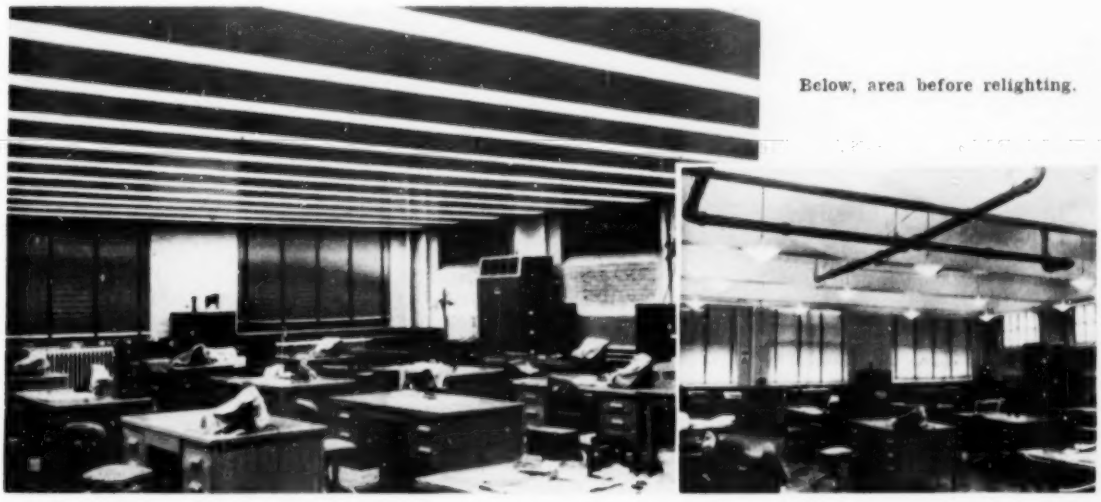
Ceiling Rehabilitation for an Old Office

A difficult ceiling problem was solved in the relighting of this office at the Attleboro Steam and Electric Co., Attleboro, Mass., with aluminum acoustical ceilings and troffers. The area, once a garage, had been reclaimed for office space as shown in the inset photo, lower right.

The 13-ft 6-inch ceiling was lowered to 9 ft 3 inches with the installation of "satin finish" aluminum acoustical panels (70 per cent reflectance) which conceal the unsightly ceiling obstructions and at the same time provide noise reduction of a high order. Single-lamp troffers employing 4 ft, 6 ft, and 8 ft T12 430-ma standard white slimline lamps are in 48-ft rows, on 40-inch centers. Initial illumination level was 85 to 100 footcandles.

Should the owners so desire, a plenum can be extended from the air-conditioner (at right in picture) to the ceiling, and air blown into the area between the natural ceiling and the overhead. With the proper fan, either cool or warm air may thus be diffused through the office without draft.

Lighting engineer was G. B. Newton, Attleboro Steam and Electric Company. Photo and data from John J. Probst, Chief Engineer, Simplex Ceiling Corporation, New York, N. Y.



Below, area before relighting.

Ventilation—
The Key to Self-Maintenance

By FLOYD W. SELL

Describing tests made on four different industrial luminaires, to investigate the self-cleaning properties of reflectors having various size and type of openings. Results indicate that ventilation is an important factor in the self-maintenance of industrial reflectors.

RESULTS of a lighting survey made in one of our shops showed a consistent pattern of less maintenance required for some types of reflectors in the area than for others. A test seemed indicated, and a study was started about two years ago, to investigate the apparent self-maintenance features of certain types of reflectors.

Our survey showed that in one machine shop, using two-lamp 40-watt industrial luminaires having an upward component of light, cleaning lamps and reflectors effected a 10 per cent increase in the illumination level. In another department, where conventional industrial closed-top reflectors were used, an improvement of 30 to 40 per cent resulted from the same routine annual cleaning. In the former case, the opening in the reflector top, for upward lighting, seemed to provide a chimney action which was keeping the reflecting surface clean. The opening, in this case, was 1¼ inches by 48 inches long, and was located off center with respect to the lamp.

Types Tested

To investigate this self-cleaning theory, a study was made of four different industrial luminaires, two fixtures having different degrees of ventilation and their companion control fixtures with no ventilation. It was thought that self-maintenance might be a function of the size of the opening, and so a fixture with a series of small openings above the lamps was chosen to compare with one having a continuous large opening over each lamp. In the area we serve the 85-watt T17 lamp is used extensively in industry, hence the choice of fixtures using that size of lamp.

Fixtures of aluminum were chosen for one group because that was the only type available which had a large continuous opening at the top. The other two were porcelain enamel, one with small openings and one closed. It is not, of course, the intent of this report to show the superiority of one reflecting surface over the other.

A paper presented before the Great Lakes Regional Conference of the Illuminating Engineering Society, Syracuse, New York, May 25, 1953. AUTHOR: Industrial Lighting Engineer, Sales Department, Detroit Edison Company, Detroit, Michigan.

The ventilated aluminum reflector had an opening directly over each lamp, 2" wide by 60" long, for a total of 240 square inches. See Fig. 1.

The porcelain enamel ventilated reflector had a series of ⅝" diameter holes displaced slightly toward the edges of the fixture for a total of 30 square inches. See Fig. 2.

Test Location and Method

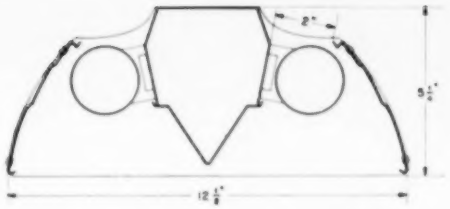
It seemed advisable to install these four test fixtures (two ventilated and two with closed tops) in an area affording easy access to them, for readings of light output each month. The balcony of our sheet metal shop fulfilled this requirement, and in addition, the fixtures would all be uniformly exposed to the acetylene and arc welding fumes as well as paint spray residue originating on the ground floor below. The mounting height was 9' 6" above the balcony floor and the fixtures were placed in two rows four feet apart with a distance of two feet separating the ends of the fixtures in each row.

A set of new lamps was installed in the fixtures with the end caps carefully marked so that these lamps could be removed and re-installed each month in the same fixture and in precisely the same position in that fixture. After about a month's operation for seasoning, these became the standard test lamps and were then used only when light output readings of the test reflectors were taken. A different set of lamps was used in the daily operation of the fixtures. These also were marked, to be always replaced in the same fixture after the monthly test readings were taken.

To insure accurate readings of reflector depreciation, the light generated by the test lamps had

to be carefully controlled. To accomplish this, a small box was constructed to house a photocell receiver. The top was open and the edges were shaped to fit half-way around a T17 lamp. This photocell was connected to a microammeter. It was felt that by holding this assembly against one of the standard lamps in each fixture it would indicate accurately on the meter the amount of light being generated. Primary voltage could then be changed to keep this light output value constant while readings were being taken. To insure sampling at the same place on the lamp, the location was marked by banding the lamp with masking tape. Several preliminary test readings indicated that this method of standardization was reliable.

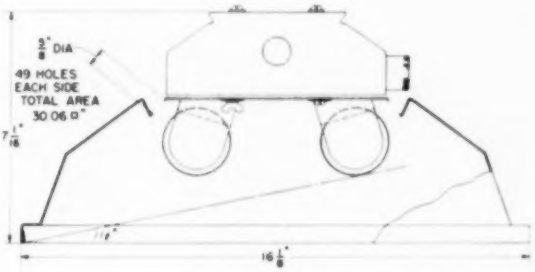
It was necessary to build a special photometer in order to measure accurately the light output from each fixture while it hung in place. To accomplish this, a wooden box was constructed, in appearance very much like a rectangular-shaped waste-basket measuring 14" x 18" at the top and tapering to 4" x 6" at the bottom. It was 18" deep. A piece of opal diffusing glass was fitted in the top and grooves cut into the top rim of the box to receive the bottom edges of the fixture. Orientation marks were placed on each fixture and on the box so that the photometer could always be placed against the fixture in the same location. A small opening was provided in one side at the bottom for insertion of the photocell receiver of a Weston footcandle meter.



Zone	% Light Output
0° - 180°	78.2
90° - 180°	27.5
0° - 90°	50.7
0° - 60°	44.6

2 openings 2" x 60" = 240 sq. in.

Figure 1. Ventilated Aluminum.



Zone	% Light Output
0° - 180°	82.5
90° - 180°	2.0
0° - 90°	80.5
0° - 60°	63.0

Figure 2. Ventilated Porcelain Enamel.

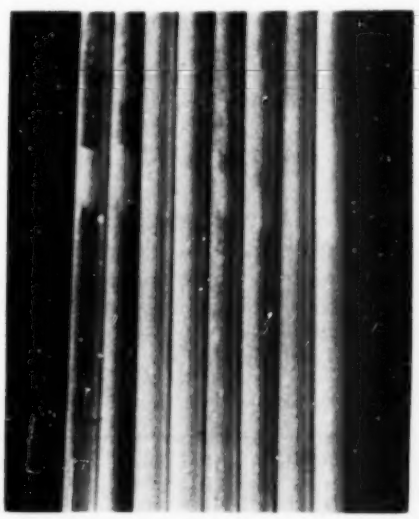


Figure 3. Each month the operating lamps were removed and stacked as shown here. In pairs from left to right, they are: aluminum ventilated, aluminum closed top, porcelain enamel ventilated, and porcelain enamel non-ventilated.

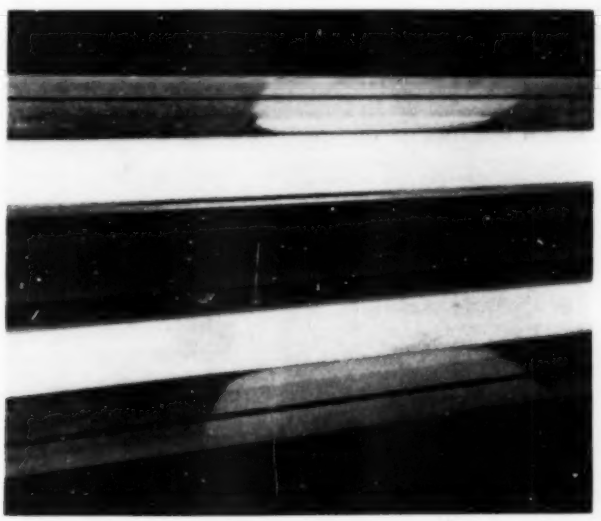


Figure 4. Non-ventilated luminaire after 10 months operation. A section, of course, has been cleared in the center to show the contrast.

Figure 5. A reading being taken on the non-ventilated aluminum luminaire. The small box with photo-cell receiver for standardizing light output of the lamps is in the left hand while the waste basket photometer in the right hand is being held against the bottom of the unit to measure light output of a center section of the reflector.

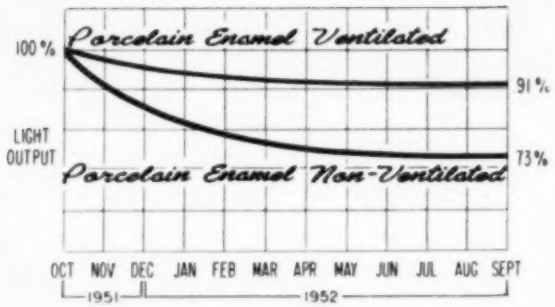


Figure 7. Reflector maintenance study—porcelain enamel.

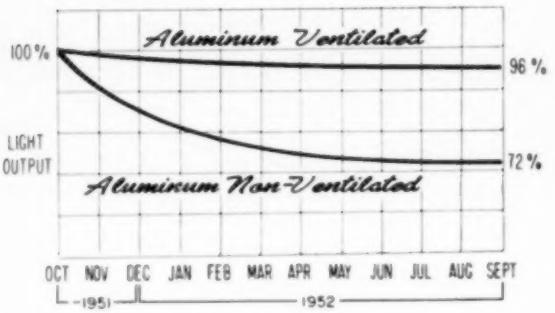


Figure 8. Reflector maintenance study—aluminum.

The interior of the photometer was lined with diffuse Alzak aluminum.

Test Procedure

Observations were made each month by holding the photometer up to the bottom of the fixture to take a sampling of light output in the center section. Our initial measurement was made in October 1951 and this procedure was repeated each month until September 1952, at which time the reflectors were washed and we were able to repeat the initial readings. Efficiencies were computed from this data and the results are shown in Figs. 6 and 7.

Ventilation does contribute substantially to the self-cleaning of industrial fluorescent reflectors. Even a small amount of ventilation does a surprisingly good job of keeping the reflecting surface clean. Fixtures which provide a greater upward component of light to obtain visual comfort in the shops should pay good dividends in self-maintenance.

I wish to acknowledge with thanks the help of Mr. Theodore Roughley and Mr. Philip Harrigan, of our Research Department, for the design of the photometer and technical assistance in conducting the test.

See list of Sustaining Members on pages 24A, 27A, 28A, 32A

A.I.A. File No. 31/

INSTALLATION AT GRAND LODGE OF MASONS, IONIC HALL, 51 BOYLSTON ST., BOSTON, MASS.

Lighting a Masonic Assembly Room

LIGHTING OBJECTIVE: To provide a flexible system of illumination for the ritual activities of a Masonic lodge.

GENERAL INFORMATION: The room measures 80 x 42 x 20 feet. Surface characteristics are as follows: very light blue ceiling (47% RF); light blue upper walls (38% RF); dark blue lower walls (26% RF); white columns (86% RF); blue carpeted floor (5% RF) and blue upholstery (5% RF).

INSTALLATION: General downlighting of 45 foot-candles is provided by Century No. 368 units, with baffles, using 150-watt PAR-38 floodlamps spaced 5 feet apart. Mounted behind the columns to illuminate the walls are 12 aluminum spinnings, each with a 150-watt R-40 floodlamp covered with a light pink heat-resisting glass roundel. The letter "G" is illuminated by a Century No. 1653 ellipsoidal specular Alzac reflector spotlight containing a 400-watt G-30 incandescent filament lamp and plano convex lens for accurate beam control; four-way adjustable shutters can frame the light sharply to fit any triangular or quadrilateral shape within its normal 50-degree conical beam. This unit is located approximately 6 feet from the wall containing the "G." Another similar unit in the center of the ceiling illuminates the Bible.

Brightnesses are as follows:

floor	1.5 ft-L
wall	
opposite organ	.58 ft-L
spot around "G"	4.5 ft-L
ceiling	.67 ft-L

All lamps are dimmer-controlled.

Lighting designed by Henry A. Klopot, Boston, Mass.
Lighting data submitted by Henry A. Klopot, 132 Newbury Street, Boston, Mass., as an illustration of good lighting practice and to aid in the design of similar installations.
Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Series XVIII 9-53

A.I.A. File No. 31/

Questions and Answers on light sources

The I.E.S. Committee on Light Sources, under the chairmanship of G. S. Evans, has prepared the following discussion to answer a frequently-asked question.

Do fabrics fade more quickly under natural daylight, incandescent, or fluorescent lamp lighting?

The problem of fading is one on which many thousands of dollars have been spent in an effort to reduce the very large losses which have occurred in the textile industry, museum exhibits and other fields.

Many variables, such as temperature, humidity, chemical contamination of the air, light intensity, hours of exposure, chemical contents of the dye, even the color of the dye and the type of light source, contribute to the fading process in varying degrees. The complexity of this particular problem makes it very difficult to assign specific causes.

Tests of many textile specimens have established the following generalizations:

(1) With a given light source, fading is proportional to the length of time of exposure and also to the illumination level.

(2) Since fading is a photochemical reaction, oxygen is an important factor and enclosure of the material in a vacuum greatly reduces the effect.

(3) Humidity seems to have a rather minor effect, but possibly very high humidity operates to modify the texture of the material under test, thus changing the rate of fading.

(4) Temperatures of the order of 85F do not seem to have an appreciable effect on the rate of fading, but the rate increases rapidly at higher temperatures so that it is about twice as great at 150F.

(5) The particular properties of the dyes used may cause them to be more or less "light fast" and this property may be selective with respect to other factors.

(6) The wavelength of the light source is important. Radiation throughout the ultraviolet and visible spectrum up to approximately 580 millimicrons produces fading. Ultraviolet in the light source has been considered a major factor, but tests have been conducted which show that very little fading is caused by the ultraviolet as found in daylight and common artificial light sources. It is believed that light from the blue end of the visible spectrum contributes a great deal to the fading and red light causes little or no fading.

(7) Extensive tests on a cross section of textiles indicate a relative variation in fading produced by four light sources when the intensity of illumination and exposure time were held constant for all:

Light Source	Relative Fading Power
North skylight	100%
Midsummer sunlight plus skylight	50%
Daylight fluorescent lamps	29%
Incandescent filament lamps (500-watt)	28%

Exposure of material to direct sunlight will generally produce more rapid fading than north skylight, but it must be remembered that the intensity of sunlight is usually many times that of north skylight. It must also be considered that daylight varies greatly, depending on the hour of day, the season of year and the location.

Any or all of these factors may be present, and definite evaluation and prediction are practically impossible. It can be said that with the same materials being tested and with the same light source, the rate of fading seems to be related to the footcandle hours of exposure. Under equal footcandle hours of exposure, natural daylight has been shown to produce more rapid fading than incandescent and daylight fluorescent sources.

See pages 18-7 to 18-9, *I.E.S. Lighting Handbook*, Second Edition.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

I.E.S. Gold Medal Nominations Due January 1

Nominations for the Society's highest award — the I.E.S. Gold Medal — are now being considered by the Medal Award Committee. Nominations for the award are invited from all members — closing date for their receipt is January 1, 1954.

The I.E.S. Gold Medal is awarded for the purpose of giving recognition to meritorious achievement which has conspicuously furthered the profession, art or knowledge of illuminating engineering. In making nominations for the Award, the following points should be observed.

(1) Candidates for the award need not be members of the Society, nor citizens of the United States or Canada, and may be nominated at any time by any member of the Society, by presenting to the General Secretary at Society Headquarters the name of the individual whose accomplishments in his field are deemed worthy of such recognition, whether it be in the field of engineering, design, applied illumination, optics, ophthalmology, lighting research, education, or administration and management.

(2) In order for a candidate to be considered for the award of a given year, a letter requesting consideration of the proposed candidate shall be delivered at the General Office of the Society before January 1 of that year.

(3) Nominations and records on file in the General Office from previous years, as reviewed and referred to the next year's committee by the previous Medal Award Committee, will be given consideration along with any new nominations.

The I.E.S. Gold Medal was established in 1944. Accompanied by an appropriately engrossed certificate of award, it has been presented in past years to: George H. Stickney, Preston S. Millar, E. C. Crittenden, Matthew Luckiesh, Sir Clifford Paterson, Ward Harrison and William F. Little. Last year's recipient was H. H. Magdsick.

Membership Campaign Winners Announced

As members in all Sections and Chapters know, a touch-and-go race has been underway all year in the keenly contested I.E.S. Membership Campaign. For anyone who watched it closely, it could be as interesting as the recently-closed pennant race. Final standings were announced (ironically enough in Chairman Dick Slauer's Memo. No. 13) early in August. His summary of the contest's outcome showed:

Group No. 1 (over 200 members) — Northern California (first) — Southern California (second).

This ending represents a double repeat. Southern California tried hard to reverse the order — its net gain was more than both Sections together in the previous year. But Northern California recognized the challenge and kept ahead.

Group No. 2 (100-199 members) — St. Louis (first) — Georgia (second).

The success of St. Louis was phenomenal — a 60 per cent growth. What makes this all the more remarkable is that St. Louis is an older Section, presumably stabilized. The growth came from the basic area, not from some remote city which represented an embryo Chapter. Without question, such results in such circumstances had to come from hard work by a good team, inspired leadership and the ability to think big enough to convince the proper people that the I.E.S. was a vital organization representing leadership in its field, which prospective new members could not afford to ignore. With the type of leadership and team work shown by St. Louis, perhaps the expressed desire for a 10,000 I.E.S. membership need not be consid-

Fundamentals of Illumination — Annual Course by New York Section

A twelve-week course in Fundamentals of Illumination is again being presented by the New York Section, I.E.S. Lecturers for the sessions this year as Gene G. Rae, Holophane Co.; L. R. Anderson, General Electric Lamp Division; L. Goren, Globe Lighting Products, Inc.; and R. L. Zahour, Westinghouse Electric Corp.

September 21 — Theory of Light and Control — R. L. Zahour.

September 28 — Illumination Terms — R. L. Zahour.

October 5 — Filament and Electric Discharge Lamps — R. L. Zahour.

October 19 — Fluorescent Lamps and Auxiliaries — L. R. Anderson.

October 26 — Equipment Design — L. Goren.

November 2 — Lighting Requirements — L. Goren.

November 9 — Illumination Computations — L. Goren.

November 16 — Computation and Maintenance — L. R. Anderson.

November 23 — Industrial Lighting — L. R. Anderson.

November 30 — Lighting for Seeing — G. G. Rae.

December 7 — Light for School and Office — G. G. Rae.

December 14 — Economics of Lighting — G. G. Rae.

Classes will be held at the Consolidated Edison Building, Room 815, 4 Irving Place in New York City. Tuition is $10 for members of I.E.S., A.I.E.E. and A.I.A.; $20 for all others. For further information and for enrollment, address Gene G. Rae, The Holophane Co., Inc., 342 Madison Avenue, New York 17.

I.E.S. National Technical Conferences

September 12-16, 1954 — Chalfonte-Haddon Hall, Atlantic City

September 12-16, 1955 — Statler Hotel, Cleveland

September 16-21, 1956 — Statler Hotel, Boston.

ered wishful thinking. And as for Georgia — its 40 per cent increase would have been over-all tops in many a contest!

Group No. 3 (50-100 members) — Indiana (first) — Arizona (second).

Last year's members of Group 3 must be muttering to themselves about these winners — Indiana did so poorly last year that it dropped down from Group 2; Arizona did so well that it advanced from Group 4. Both must have liked the hospitality of Group 3 — after a close struggle with New Orleans, Alamo, and Eastern New York, they head the list.

Group No. 4 (under 50 members) — Mid South (first) — New Mexico (second).

Among the smaller Chapters, percentage swings tend to be large. But no one can use this as an excuse to ignore a growth of 156%. This means that there are 50% *more* newcomers than those who constituted the group at the start of the year. New Mexico, like Georgia, can feel unlucky — a 40% increase is more often tops than second.

Mr. Slauer's summary indicates that as a whole, membership growth did very well. Membership in the Society is at an all-time peak — just under 8000 including Student Members. Growth for 1952-1953 was 6.1 per cent, a little less than double last year's growth.

Interesting Gavel Presented To Oklahoma Section

Chairmen of the Oklahoma Chapter of I.E.S. from now on can call the meeting to order with a good loud thump. Their gavel, presented to the Oklahoma Chapter recently by the Arizona Chapter is made of heavy ironwood, native to Arizona, and banded with Arizona copper. It was designed by member Milo White of the donor Chapter and was made in the Public Service of Arizona shops. Characteristics of ironwood are its weight and small checks on the surface of the wood.

St. Louis Section Plans To Honor Associated Groups

One interesting feature of the St. Louis Section meetings this coming year will be the coordination of the meeting topic with some associated group in the lighting industry. The first meeting, September 24, fitly enough, honors the Society Members. The October meeting will honor contractors and the November meeting will be in conjunction with jobbers. A meeting is planned for architects and one for School Boards.

Lamp Fashion Festival Launches New Approach to Home Lighting

A very practical and coordinated approach to home lighting design was launched in Cleveland July 28 and 29, at a meeting attended by some 200 utility executive, portable lamp manufacturers and retailers. Sponsored jointly by the Lamp and Shade Institute of America, and the General Electric Lamp Department, the program is aimed at establishing I.E.S. lighting effectiveness standards in portable lamp design, and at the same time good design in lamp construction.

The wide availability of such portable lamps has long been the separate goal of both home lighting specialists and interior designers. A coordinated effort has now been made by both groups during the past year, culminating in the new program of popularizing good looking lamps of good design which coordinate one with the other within a room, and which are also designed to give lighting results in line with I.E.S. recommended practice. Active in this cooperative effort were Gladys Miller, interior designer, and G E home lighting specialists. Another phase of the program will be promotion and merchandising of such lamps "by the roomful."

Highlight of the Cleveland meetings was a model Lamp Fashion Festival, at which new portable lamps and a radically new way to buy them were demonstrated. The "festival" was intended as a model for similar showings to be sponsored by utilities on a nationwide basis beginning this fall and continuing throughout 1954. Model rooms showed the proper use of lamps that combine good styling and comfortable lighting, and lamp groupings which will aid consumers in selecting lamps coordinated in style and design in pre-selected "roomfuls" and "housefuls." Displays showed contemporary design in low, medium and higher cost brackets, and models for traditional design at similar economic levels. Gladys Miller assembled the lamps in houseful format, and all lamps shown were pretested by home lighting specialists to meet I.E.S. recommended practice. The lamps themselves had been designed by stylists of the Lamp and Shade Institute following a conference held last winter on good home lighting requirements. The 80 or so lamps shown were prototypes of over 1500 which have already been screened by the Lamp and Shade Institute for good looks and good lighting results. The program is expected to enable any housewife to be able to take the following steps, to assure herself of good lighting and coordinated design.

1. Choose a price range.
2. Select a style, such as formal or informal, traditional or contemporary.
3. Pick out the actual lamps in the preferred design and color, and where the program is in full effect, feel secure that all the lamps will harmonize with each other and with the grouping for which they were intended.

An Alternative to The Footcandle

"Lumeritas," author of the Postscript page of the British *Light and Lighting*, offers in their June 1953 issue the following suggestio nand comments in the field of nomenclature.

"Candles are with us still, both as practical light sources and — with *foot* — as a photometric quantity. Our American friends still use the term "footcandles" generally, and it is by no means dead and buried here as yet. From time to time those who like it and those who like it not ventilate their views in the correspondence columns of this Journal. It has been suggested that the controversy might cease if an acceptable short name could be found for the unit of illumination used here and in the United States. Various names have been proposed but none has even been seconded. Musing on this, I gave my fancy its 'head' with the following fanciful result! The C.I.E. symbol for illumination is *E*, and so the wanted (?) word might aptly begin with E; those who will use it are English-speaking peoples, whose titular heads are Queen Elizabeth and Eisenhower, so again E comes to mind as the initial letter; can other letters common to these names be used to coin the wanted word? — ah, here's the rub! — however, the *s* in Eisenhower sounds much the same as the *z* in Elizabeth, so why not 'Ez'! This is even shorter than lux and needs neither a plural nor an abbreviation. What about it, U.S.A. — will you have it if we will?"

I.E.S. Project Aids Technical Committee

For the record, and for other Sections or Chapters seeking ideas, attention is directed to an exceptionally valuable project carried on last year by the Oklahoma Chapter of I.E.S. The School Lighting Committee (national) had underway a survey on brightness conditions in school rooms all over the country. Opinions of non-technical people were especially wanted. PTA groups and such were asked to sit in the rooms under study and then reply to a prepared questionnaire. Forms were sent to I.E.S. Sections for local data.

The Tulsa I.E.S. group had an even better idea. They organized a regular meeting of their Chapter for the express purpose of carrying out locally, the School Lighting Committee's survey. Invited to this survey session, held at the University of Tulsa, were architects, optometrists, salesmen and housewives. The meeting was conducted in accordance with standard classroom laboratory procedure, with the "students" conducting their own experiments and taking their own measurements. Instruments furnished were brightness meters, light meters, visibility meters, color charts with Munsell notations, shadow paddle and tape measures.

Rooms evaluated were three classrooms in the Engineering Building of the University of Tulsa: a chemical lab, an auditorium and a standard classroom. Five survey forms were used ranging in complexity from one designed for non professional observers, to a more detailed technical forum suggested by Moon and Spencer. The "class" was instructed to evaluate the quality of the artificial lighting system and appraise the colors in these three classrooms. Instructors assisted in the use of the instruments and guided the experimenters throughout the evening.

There was never a dull moment. Half of the crowd were women with no technical concepts. Salesmen, optometrists, and even architects were total strangers to the instruments and the procedure, but everyone participated enthusiastically and all were surprised to learn of the tools and procedures available for the design and appraisal of lighting systems. By the end of the meeting it was apparent that a goodly amount of technical information had been painlessly imparted to people anxious to have it but not willing to dig it out for themselves or stay awake during a typical lecture on the subject.

In addition, useful information was obtained for the I.E.S. School Lighting Committee's work on brightness conditions in school rooms.

GROUP of 66 housewives, architects, optometrists and salesmen who took part in the highly successful meeting conducted by the Oklahoma Chapter for the survey of brightness conditions in classrooms. In addition to thoroughly enjoying the meeting, the group collected data of considerable value to the I.E.S. School Lighting Committee.

PARTICIPATING in Oklahoma Chapter's ingenious meeting for the survey of brightness conditions in schoolrooms were, l. to r. Oscar Shaw, Harold Miller, Dean Langenheim, Robert Smith and Dale H. Watt.

Utility Road Show Tells Lighting Story

A two act portable road show titled "The Magic Key" is currently playing to audiences throughout Colorado, to tell homeowners the story of the electrical industry and specifically what proper lighting will do for the home. Conceived by the late G. B. Buck, and sponsored by Public Service of Colorado, the show opened May 7 in Denver before a large group of electrical contractors, architects and engineers.

The first act is an entertaining display of electrical "magic" through which is woven the story of the electrical industry as narrated by the master of ceremonies and his assistant.

Second act is a dramatic skit, which as the plot unfolds, dramatically demon-

(Continued on page 10A)

All essential ceiling components in a single integrated modular system

At each modular interval of Sigma-Plex either an acoustical baffle or a movable partition may be set in place. Sprinklers or supplementary air diffusers may be mounted at the intersections of baffles. Names of reputable manufacturers of movable partitions, high velocity venturas and sprinklers for integration with Sigma-Plex will be furnished by Wakefield.

for combining

- **lighting**
- **acoustics**
- **air diffusion**
- **sprinklers**
- **movable partitions**

that's Sigma-Plex

The architect's plea for functional compatibility of diverse components is answered once and for all by Sigma-Plex. For now the architect may design office areas of any size or shape knowing he has available to him, as standard products, a number of the most important interior elements, all ready for integration into a harmonious whole.

Job-engineered to the modular requirements of the building, Sigma-Plex as supplied by Wakefield consists of:

A Ladder-Type System of lamp holders together with lighting and wiring channels to be mounted directly on the structural ceiling. From these channels, receiving channels are suspended to support the light diffusers and to receive either acoustical baffles or movable partitions.

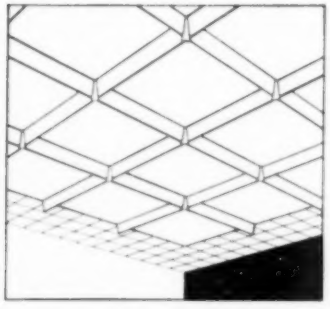
Rigid-Arch Plastic* Diffusers framed in extruded aluminum. These diffusers have a non-specular matt finish, and are arched from edge to edge for extra rigidity. A special Touch-Latch permits lowering and re-closing the panels from the floor by means of a touch rod.

**Plexiglas or Lucite.*

Acoustical Baffles of perforated metal filled with a fiber glass core. These baffles are interchangeable with movable partitions at any modular interval. Sprinklers or supplementary air diffusers may be mounted as desired at baffle intersections. Partitions, sprinklers and venturas are not supplied by Wakefield; see note on left page.

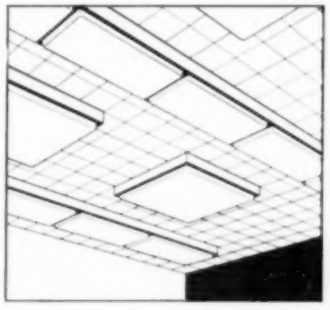
Sigma-Plex is one of a series of Wakefield Geometrics. The others:

Theta-Plex



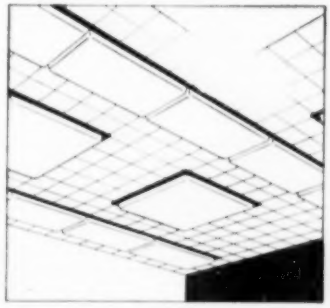
Designed on a four-foot module, Theta-Plex permits coordination of Rigid-Arch plastic diffusers, acoustical baffles, supplementary ceiling areas of acoustical tile, sprinklers and supplementary air diffusers. At each four-foot interval an acoustical baffle may be set in place; or four-foot panels may be joined together in varied combinations.

Omega-Plex



Omega-plex is a complete unit with Rigid-Arch Diffuser, ready for on-surface mounting with no structural ceiling changes required. It comes in four sizes: 1′ x 1′, 2′ x 1′, 2′ x 2′ and 1′ x 4′. Ballasts and lamp holders are contained in an individual metal housing. Omega-Plex may be used individually or combined in a variety of designs. Available with louvers.

Beta-Plex



Beta-Plex is a complete unit with Rigid-Arch Diffuser, ready for recess mounting in a suspended ceiling. It comes in 4 sizes: 1′ x 4′, 2′ x 4′, 2′ x 2′ and 1′ x 4′. Ballasts and lamp holders are contained in an individual metal housing. Employing various Beta-Plex sizes, singly or in continuous patterns, the architect can create numerous designs. Available with louvers.

An eight-page, three color folder, with illustrations, technical drawings and descriptive text, has been prepared for each of the Wakefield Geometrics. Copies will be sent you if you will write The F. W. Wakefield Brass Company, Vermilion, Ohio. In Canada, Wakefield Lighting Ltd., London, Ont.

WAKEFIELD GEOMETRICS

Integrated modular components for functional ceilings

(Continued from page 7A)

strates the contribution of lighting to home decoration and beauty. The show is so arranged that the two acts can be staged either together or separately, with the entire program taking about an hour and ten minutes. This time also includes the effect of light on color which takes place between acts while sets are being changed.

The play will be shown to schools, parent-teacher associations, service clubs and other civic organizations. The "Magic Key" has been developed, according to its sponsors, to meet the desire for a combination of good entertainment and education.

Seeing and Lighting Is Topic Of Chicago Seminar Series

A new seminar course on "Seeing and Lighting in the World Today" is being initiated by the Chicago Lighting Institute in cooperation with Northern Illinois College of Optometry. Described as a "trail-blazer," the twelve-lesson course is intended for optometrists, ophthalmologists, lighting specialists, industrial nurses, psychologists and management representatives. Carl W. Zersen, Managing Director of the Chicago Lighting Institute, will be discussion leader for the series of seminars.

The two-hour classes, held Wednesday evenings from September 30 to December 16, will cover the following topics, by the following lecturers:

September 30

The Concept of Seeing in the World Today — Dr. Richard Feinberg, Northern Illinois College of Optometry. (Introduction to the modern concepts of seeing — physical, psychological, physiological aspects of sight. The Sight-light relationship. Implications of seeing in a work-world and in recreation.)

The Concept of Lighting in the World Today — Dr. S. K. Guth, Lighting Research Laboratories, General Electric Co., Cleveland. (The broad concept of lighting and seeing to be considered. Lighting for accurate and rapid perception and for easy seeing. Lighting the entire visual environment. Coordination of all these approaches for quick, accurate, safe and comfortable seeing.)

October 7

Geometric Optics and Its Applications — Dr. Paul Shulman, Northern Illinois College of Optometry. (Basic studies in the action of light as it travels through an optical medium. Ophthalmic lenses and prisms.)

Lighting and Color Nomenclature — John O. Kraehenbuehl, University of Illinois. (Definition of basic illumination and color terms including description of the Ostwald, Munsell and C.I.E. color systems.)

October 14

Physical Optics and Its Applications — Dr. Paul Shulman, Northern Illinois College of Optometry. (Discussion of applied optical instrumentation.)

Light Sources — Samuel Eaton, Sylvania Electric Products, Inc., Chicago, Ill. (Physical characteristics of light, theories of light; characteristics of light sources, e.g., incandescent, fluorescent and vapor lamps.)

October 21

The Anatomy and Physiology of the Human Eye — Dr. Lester Rice, Northern Illinois College of Optometry. (Gross description of the human eye. Its tunics and optical media. Description of the eye muscles and ocular appendages. Eye movements. Convergence and accommodation. The presbyoptic eye.)

Lighting Standards — L. V. James, Illumination Consultant, La Grange, Ill. (Factors that influence the establishment of standards. Discussion of standards available today.)

October 28

The Measurements of Vision — Part I — Dr. Frederick Kushner, Northern Illinois College of Optometry. (The Snellen Fraction. Measurements of vision and loss of vision in percentages. Visual screening tests. Color vision tests. The Visual Recognition Chart. Skills and fields.)

Lighting Measurements — Part I — Harry Horn, University of Illinois. (Introduction to laboratory instruments, including the integrating sphere, reflectometer, photometer heads, and spectograph.)

November 4

The Measurements of Vision — Part II — Dr. Frederick Kushner, Northern Illinois College of Optometry. (Definition of the different eye professions. Description of the routine optometric visual analysis.)

Lighting Measurements — Part II — Harry Horn, University of Illinois. (The foot-candle, brightness and visibility meters described and discussed. Laboratory and practical methods outlined.)

November 11

Visual Psychology — Part I — Dr. Thaddeus Murroughs, Northern Illinois College of Optometry. (Attention and perception in relation to vision. The laws of learning as a basis for visual training.)

Brightness, Contrast — John O. Kraehenbuehl, University of Illinois. (Current illuminating engineering concepts, specifications of the relationship between brightness and contrast in illumination.)

November 18

Visual Psychology — Part II — Dr. Thaddeus Murroughs, Northern Illinois College of Optometry. (Psychological approach to color vision. Stereopsis. Positive and negative images. Color blindness.)

Residential Lighting Design — Charles L. Laupp, Wisconsin Electric Power Co. (Functional visual activities in the home and practical lighting solutions. Decorative lighting techniques.)

November 25

School Vision — Dr. Alfred Rosenbloom, Jr., Northern Illinois College of Optometry. (Visual skills and visual environment necessary for satisfactory performance in school and study. The seeing problems of school children.)

School Lighting Design — William Foulks, Curtis Lighting, Inc. (How to provide the type of lighting which will produce comfortable seeing conditions in the classroom, illustrated with slides.)

Oops!

To correct the report on the East Central Regional Conference, July I.E., the winner of the Capital Section contest for My Most Interesting Lighting Job was Herbert A. Friede, Electrical Engineer, District of Columbia. Mr. Friede presented his entry at the Baltimore Conference.

December 2

Industrial Vision — Dr. Richard Feinberg, Northern Illinois College of Optometry. (The application of ophthalmic knowledge to the occupational field. Seeing demands on the job and how they are met. The relationship of seeing, production, human welfare and loss prevention.)

Industrial Lighting Design — B. S. Benson, Benjamin Electric Mfg. Co., Des Plaines, Ill. (Discussion on providing lighting for safety and production in industry, accompanied by slides.)

December 9

Motor Vehicle Driver's Vision — Dr. Richard Feinberg, Northern Illinois College of Optometry. (An exploration of vehicle driver's vision. Vision standards in the various states. Tests for driver vision.)

Highway Lighting — Richard Seitz, Public Service Division, Commonwealth Edison Co., Northbrook, Ill. (The lighting engineer's contribution to providing better night-time vision on highways and expressways in and around Chicago.)

December 16

3-D Motion Pictures and Seeing — Dr. Thaddeus Murroughs, Northern Illinois College of Optometry. (The problems of stereopsis and movie viewing. Detection of the deficient-sighted through viewing 3-D. Influence of 3-D motion pictures on vision training and seeing.)

3-D Motion Pictures and Lighting — Carl F. Jensen, Westinghouse Electric Corp., Lamp Department, Chicago, Ill. (Discussion and demonstration of the mechanical and illumination principles involved in the various types of three dimensional projection.)

Tuition for the entire course is $25.00. Sessions will be held at the Chicago Lighting Institute, 37 South Wabash Avenue, or at the Northern Illinois College of Optometry, 830 East 42nd Place at Drexel Blvd.

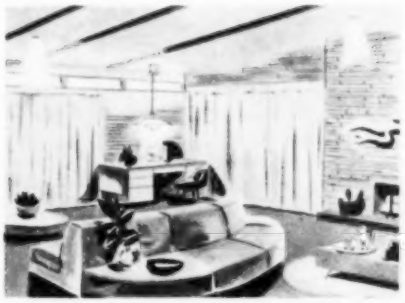
Excerpts from the President's Newsletter

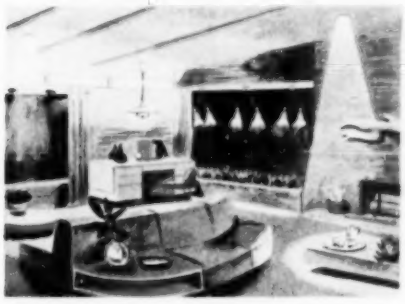
In his "newsletter" to officers of the Society, which is sent some four or five times a year, I.E.S. President E. M. Strong has mentioned items of general interest to all members. Newsletter No. 4, for example, contained several such items; for instance:

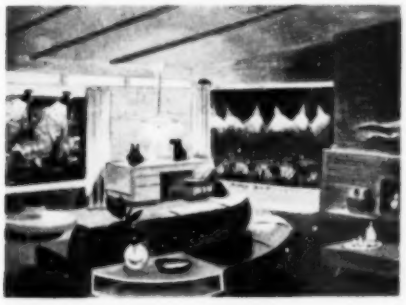
In Every Industrial Establishment. The officers of the Society were deeply gratified this Spring in the recognition given by Washington to one of our most important Standard Practices. We cooperated with the U. S. Department of Labor in making available 10,000 reprints of the American Standard Practice of Industrial Lighting, published under a special cover title of "Industrial Lighting." William L. Connolly, Director of the Department's Bureau of Labor Standards, wrote — "We feel as you do that such information should be available in every industrial establishment." Mr. Connolly said further, "We use this standard as the basis for one of our training courses in safety, which reaches not only representatives from State labor

(Continued on page 13A)

Captures Client Imagination!







Inspiration-Lighting by MOE LIGHT

Inspiration-Lighting by MOE *Light* is a revolutionary new approach that enables you to make more dramatic layouts . . . that helps you to sell lighting effects, not merely lighting fixtures.

Peggy Clark, creator of fabulous lighting effects for many leading Broadway productions such as "Pal Joey," "Brigadoon," and "High Button Shoes," has adapted her ideas to home use . . . now tells how to "paint with light," create a mood, change the personality of a room—simply by flicking a light switch. MOE *Light* Contemporary, Traditional, Accent, Recessed and Wall Lighting work wonders in bringing out the full beauty of furniture, draperies and floor coverings, too.

WRITE FOR THIS HELPFUL LITERATURE

Contact your MOE *Light* distributor for a free MOE *Light* catalog. Better yet, send $1.00 for the sensational 48 page book, "YOUR HOME and *Inspiration-Lighting*." You'll find it a tremendously helpful sales-tool with page after page illustrated in rich full color . . . scene after scene of breathtaking ideas and suggestions for applying Peggy Clark's *Inspiration-Lighting* methods. This primer tells how to change the scene without changing the scenery.

MOE *Light*, Inc., Dept. E-953, Fort Atkinson, Wisconsin

☐ Send me a free MOE *Light* Catalog.

☐ Send me your glamorous, new 48 page book, "Your Home and *Inspiration-Lighting*" for $1.00. If I am not completely satisfied with the numerous suggested room layouts and ideas for applying Peggy Clark's *Inspiration-Lighting*, I can return the book to MOE *Light* within 10 days for a full refund. (Available only from MOE *Light*, Inc., Ft. Atkinson.)

NAME _____ CO. _____

ADDRESS _____

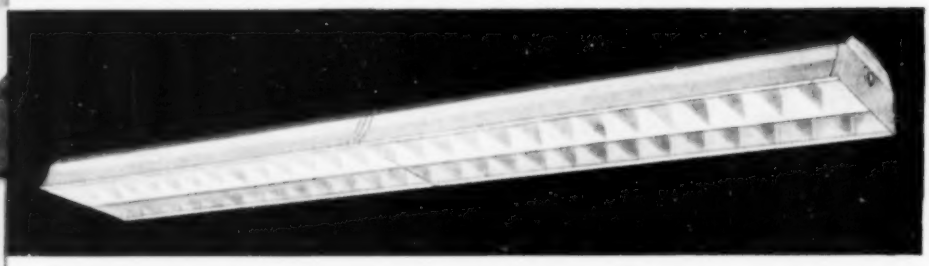
CITY _____ ZONE _____ STATE _____

MOE LIGHT, INC.

FORT ATKINSON • WISCONSIN

Electro Silv-A-King
REPORT CARD
CONTROL: Low brightness control achieved through the more equal distribution of down light and up light provide ideal illumination for better seeing.
ADJUSTMENT: Available in 3 degrees of shielding: 35° x 25°—35° x 45°—45° x 45°.
APPEARANCE: Louver fins are equi-spaced for added attractiveness. Give the appearance of one fixture when in continuous mounting.
CLEANLINESS: Easier to maintain due to the use of spring tension latches in all four corners—every four feet. Hinges from either side and is easily removed.

Report card on the new "20/20"



newest, finest lighting for schools

First in its class! The new "20/20" is designed to rate highest in lighting efficiency, ease of installation and economy of operation. Restyled for added attractiveness, the complete line offers you new opportunity to provide more satisfactory levels of illumination within the limits of your budget.

Available in:

- 2-lamp and 4-lamp 40W Fluorescent or Rapid Start
- 2-lamp, 4 and 8-foot Slimline
- 4-lamp, 4-foot Slimline
- 1 piece 8-foot channel using 4 40W lamps, 2 in parallel—2 in tandem
- Metal or styrene side panels

Available with Slide Grip Hanger for mounting anywhere along the channel.

Electro Silv-A-King, one of the industry's most comprehensive sources for every type of lighting, offers you two manufacturing and shipping points to insure rapid delivery of Fluorescent, Incandescent and Floodlighting fixtures for commercial and industrial use, indoors and outdoors. Only Electro Silv-A-King also offers you the "Basic Unit" which permits easy interchangeability of 7 luminaries on one basic chassis . . . and the "One-Man" Speedy Hanger that cuts installation man hours in half.

For completely illustrated catalog, write to . . .

ELECTRO SILV-A-KING CORP.

2000 West Fulton Street, Chicago 12, Illinois

Fairfield and State, Bridgeport 5, Connecticut

(Continued from page 10A)

departments but also a considerable number from the ranks of both management and labor. Each student is provided with a copy of these recommended practices, and through this medium we reach several hundred key people each year who might otherwise be unfamiliar with your excellent publication."

Occupational Vision. Several of our Sections and Chapters have taken part in conferences this year directed toward a discussion of problems in occupational vision. These most valuable occasions bring together representatives of our profession with members of the optometric profession and representatives of industry and public welfare and safety agencies. Interesting items appear in recent issues of our Journal — reporting on several of these conferences at Michigan State College co-sponsored by the Michigan Section, at Wilkes College co-sponsored by the Eastern Pennsylvania Section, at the Georgia Institute of Technology co-sponsored by the Georgia Section, and at the Rochester Institute of Technology co-sponsored by Rochester Section.

Frequent Dividends. The dividends to our membership and through them to the public continue to flow from the grand organization of technical committees headed up by our President-elect Homer Manwaring and ably aided by Technical Director C. L. Crouch. Such reports as the American Standard Practice for Industrial Lighting, the I.E.S. Recommended Practice for Residence Lighting, the American Standard Practice for Street and Highway Lighting are several of the more important accomplishments during the current year. Back of these are long hours of meetings, conferences, and editorial labors. Council gets a glimpse of these in the periodic reports received on the Technical Committee program.

How Do Your Groceries Look? The Committee on Color Rendition of the Light Source Committee continues to work on a method of measuring and specifying the color rendition properties of light sources, and, in particular, fluorescent lamps. The work consists of two phases, (1) establishing a standard of judgment, and (2) a comparison of current fluorescent sources with the standard. A recent inspection of metameric pairs, Munsell papers and groceries of various kinds convinced the Committee of the degree of difference between the color rendition of the lamps and particularly the possibility of reaching good agreement among observers as to the numerical scoring of these differences.

When You Are in a Fog. The Street and Highway Lighting Committee met at Atlanta, Georgia, inspected the re-lighting program and continued the study of the Committee. The American Standard Practice approved by ASA was announced. A new committee on fog lighting has been appointed and is making intensive study at the request of the New Jersey Turnpike authority.

New Lists of Speakers. Again this year we have an excellent response from our Sustaining Members in suggesting speakers for 1953-1954 Section and Chapter meetings and Regional Conferences. This list has just been duplicated at headquarters and goes out to all local and regional officers. This cooperation by our leading technical men brings the latest in lighting knowledge and techniques to our general membership. May I urge careful planning by all concerned so that speakers who come a considerable distance can be scheduled to address several groups in an area, or en route. The effective use of this list of qualified lighting experts can result in a series of stimulating and valuable meetings during 1953-54.

LIGHTING CALENDAR

Society Events

September 14-17, 1953—Illuminating Engineering Society, National Technical Conference, Commodore Hotel, New York, N. Y.

September 12-16, 1954—Illuminating Engineering Society, National Technical Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

Industry Events

September 21-26, 1953 — International Association of Electrical Inspectors, 25th Jubilee Meeting, Edgewater Beach Hotel, Chicago, Ill.

September 23-25, 1953—Canadian Electrical Manufacturers Association, Annual Meeting, General Brock Hotel, Niagara Falls, Ont.

September 29 - October 2, 1953 — National Electrical Industries Show, 69th Regiment Armory, New York, N. Y.

October 5-8, 1953—International Municipal Signal Association, Neil House, Columbus, Ohio.

October 5-9, 1953—Society of Motion Picture and Television Engineers, Semi-Annual Convention, Hotel Statler, New York, N. Y.

October 6-8, 1953 — Fourth Industrial Electric Exposition, William Penn Hotel, Pittsburgh, Pa.

October 14-17, 1953—Joint Meeting of the American Society for Engineering Education and Educational Council for Professional Development, Hotel Statler, New York, N. Y.

October 19-21, 1953 — American Standards Association, 35th Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

October 19-23, 1953—National Safety Council, 41st National Safety Congress & Exposition, Chicago, Ill.

November 2-6, 1953—American Institute of Electrical Engineers, Fall General Meeting, Muehlebach Hotel, Kansas City, Mo.

November 9-12, 1953 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

November 16-20, 1953 — National Electrical Contractors Association, Miami Beach, Fla.

November 29 - December 4, 1953 — The American Society of Mechanical Engineers, Annual Meeting, Statler Hotel, New York, N. Y.

December 2-4, 1953—National Association of Manufacturers, Annual Convention, Waldorf-Astoria Hotel, New York, N. Y.

January 11-14, 1954—National Rural Electric Cooperative Association, National Convention, Miami, Florida.

January 18-22, 1954 — American Institute of Electrical Engineers, Winter General Meeting, New York, N. Y.

January 25-28, 1954—Plant Maintenance & Engineering Show, International Amphitheatre, Chicago, Ill.

March 8-11, 1954—National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

May 3-7, 1954—Society of Motion Picture and Television Engineers, Semi-Annual Convention, Hotel Statler, Washington, D. C.

May 13-14, 1954—Public Utilities Advertising Association, National Convention, Hotel Statler, Boston, Mass.

June 6-11, 1954 — National Association of Electrical Distributors, 46th Annual Convention, Atlantic City, N. J.

June 21-25, 1954 — American Institute of Electrical Engineers, Summer General Meeting, Los Angeles, California.

Plant Maintenance Show To Be Held in Chicago

The Plant Maintenance Show, held for the past four years in the East, will move to Chicago for the 1954 exposition, acording to Clapp and Poliak, Inc., producers of the exposition. It was also announced that the name will be changed to the Plant Maintenance and Engineering Show. The exposition will take place at the International Amphitheater, January 25-28, inclusive.

Concurrently with the show, the Plant Maintenance and Engineering Conference will be held at the Hotel Conrad Hilton. For the fourth successive year, the conference broke attendance records for technical sessions of this type, with more than 2100 in attendance at the 1953 meeting. Advance registration cards may be obtained from Clapp and Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

(Telecast continued on page 14A)

Winners Announced for Electrical Contractors Lighting Contest

The nation-wide lighting contest for electrical contractors, sponsored by *Electrical Construction & Maintenance* magazine, came to a close August 14 with the final judging of the large number of entries received from electrical contractors in all parts of the country. The contest, which opened last January, was designed "to encourage and to extend public industry recognition to electrical contractors and their employees who initiate, sell and install outstanding lighting installations, and to further the dissemination of meritorious lighting information." It was divided into classes for stores, schools and offices, industry, residences, floodlighting and miscellaneous.

Eighteen cash awards, totalling $1050 and 13 honorable mentions were awarded to electrical contractors in eleven states. First prize winners received cash prizes, for each classification, of $100; second $50, and third $25. Certificates of award were issued to all prize winners and to winners of honorable mention. In addition, prize-winning entries will be featured in forthcoming issues of the magazine.

An impressive panel of judges was assembled for the final judging in New York. These were: Prof. Everett M. Strong (Cornell University), President of I.E.S.; Carl W. Zersen, managing director of the Chicago Lighting Institute as chairman; Richard Kelly, lighting consultant, New York City; Joseph S. Schuchert, commercial sales manager, Duquesne Light Company, Pittsburgh, Pa.; and Willard W. Thompson, consulting electrical engineer, Thompson Engineering Company, Boston, Mass.

Winners, as announced by the magazine August 26 were:

1. Stores

First Prize: Edward B. Barber, Independent Wiring Co., Philadelphia, Pa. — Speare Bros., Chester, Pa.

Second Prize: Lyle E. Johnson, Juneman Electric Co., Inc., Birmingham, Ala. —Loveman Joseph and Loeb, Birmingham, Ala.

Third Prize: Francis E. Havener, Rockland, Me.—Waldeboro Garage Co., Rockland, Me.

Honorable Mentions: Earl Pridemore, Pacific Electric Co., San Diego, Calif. — Krafts Drug Store, San Diego, Calif.
V. R. Knight, California Electric Works, San Diego, Calif. — Capri Jewelry, San Diego, Calif.
Eugene G. Lombard, Lombard Electric Co., Wauwatosa, Wis. — Michael M. Sedler Jewelry Store, Wauwatosa, Wis.

LIGHTING AUTHORITIES study an entry in Lighting Competition for Electrical Contractors, sponsored by *Electrical Construction and Maintenance* magazine. These experts selected the award winners in the nation-wide contest. They are (seated, l. to r.) Professor Everett M. Strong, Cornell University, Ithaca, N. Y. and President of I.E.S.; Carl W. Zersen, Chicago Lighting Institute, chairman of judges; Willard W. Thompson, Thompson Engineering Co., Boston; (standing, l. to r.) Richard Kelly, Lighting Consultant, New York City; and Joseph S. Schuchert, Duquesne Light Co., Pittsburgh.

2. Schools and Offices

First Prize: M. R. Minto, MacNutt Electric Co., New York, N. Y. — Western Electric Co., New York, N. Y.

Second Prize: T. J. Reilly, Frame Electric Co., Pittsburgh, Pa.—Hospital Service Assn. of Pittsburgh, Pa.

Third Prize: Frank R. Haubelt, Haubelt Electric Co., Pittsburgh, Pa. — Convair Inc., Pittsburgh, Pa.

Honorable Mentions: T. J. Reilly, Frame Electric Co., Pittsburgh, Pa. — Heppenstall Co., Pittsburgh, Pa.
John E. Cook, Independent Wiring Co., Philadelphia, Pa. — Art Metal Construction Co., Philadelphia, Pa.
J. D. Dunlop, East Liberty Electrical Service, Pittsburgh, Pa. — Progressive Home Federal Savings and Loan Assn., Pittsburgh, Pa.
S. C. Blumenthal, Jr., Blumenthal-Kahn Electric Co., Inc., Baltimore, Md. — Emerson Drug Co., Baltimore, Md.
Frank R. Haubelt, Haubelt Electric Co., Pittsburgh, Pa. — Suburban Savings and Loan Assn., Brentwood, Pa.

3. Industrial

First Prize: W. G. Stockhausen, Central Electric Co., Baltimore, Md. — Anderson Chevrolet Motors, Inc., Baltimore, Md.

Second Prize: W. M. Hertel, Jr., Hertel Electric Co., Grand Rapids, Mich. — Goodrich Welding Equipment Corp., Hudsonville, Mich.

Third Prize: James Maniscalco, Norristown, Pa.—Norris Iron & Wire Works, Bridgeport, Pa.

Honorable Mentions: None awarded.

4. Residential

First Prize: Edgar Sattes, Forest City Electric Co., Cleveland, Ohio — G. L. Postlethwait — Residence, Beren, Ohio.

Second Prize: Robert Smith, Jr., Philadelphia, Pa. — H. B. Robinson Residence, Rydal, Pa.

Third Prize: George Harry Meese, George Meese Electric Co., Carlsbad, Calif. — Emma Coats Residence, Carlsbad, Calif.

Honorable Mentions: None awarded.

5. Floodlighting

First Prize: M. R. Minto, MacNutt Electric Co., New York, N. Y.—Franklin Savings Bank, New York, N. Y.

Second Prize: George P. Bailey, George P. Bailey & Sons, Bristol, Pa. — United States Concrete Pipe Co., Croyden, Pa.

Third Prize: Donald Press, Flood-Lite Service, Inc., Los Angeles, Calif.— City of Cars, Los Angeles, Calif.

Honorable Mentions: Agnes Whitfield, McGee Electric Co., Clearwater, Fla. — The Five Palms, Clearwater Beach, Fla.
Lyle E. Johnson, Juneman Electric Co., Inc., Birmingham, Ala. — Loveman, Joseph & Loeb, Inc., Birmingham, Ala.

(*Continued on page* 16A)

the architects fixture...

Director is available for two, three, four and six T-12 96", 73" or 48" Slimline Lamps and for 48" Bi-Pin Lamps—Regular or Rapid-Start.

Smithcraft DIRECTOR

More than just another lighting fixture . . . because it provides large area-of-light source that blends with overhead architecture without imposing on the eye the dominance of the conventional fixture. For distinctive beauty, for superlative lighting characteristics and for the versatility of design it permits, the Smithcraft Director is in a class by itself. Make it a "must" to consider the Director before planning new installations or before re-lighting.

Shown here is the 6-light 8-foot Director in continuous row. Each unit provides over 24 square feet of unobstructive area-of-light source.

AMERICA'S FINEST FLUORESCENT FIXTURES by

Smithcraft
LIGHTING DIVISION
CHELSEA 50, MASSACHUSETTS

(Continued from page 14A)

6. Miscellaneous

First Prize: Fay Foster, Stoneburner-Verret Electric Co., Port Arthur, Tex.—Merchants National Bank, Port Arthur, Tex.

Second Prize: George A. Denner, Clement Electric Co., Grand Rapids, Mich.—Y.M.C.A., Grand Rapids, Mich.

Third Prize: Leo Stacer, Stacer Electric Co., Homestead, Pa.—Slovak Sokol—63, Homestead, Pa.

Honorable Mentions: Robert Moser, Moser Electric Co., Fort Worth, Tex.—W. T. Waggoner Bldg. lobby, Fort Worth, Tex.

T. J. Reilly, Frame Electric Co., Pittsburgh, Pa.—Mellon National Bank & Trust Co., Pittsburgh, Pa. and J. M. Wallace Memorial United Presbyterian Church, Pittsburgh, Pa.

OBITUARIES

Frank Cary Caldwell, Member Emeritus of the Illuminating Engineering Society, died recently at the age of 84. Professor Caldwell's contributions to illuminating engineering were diverse and innumerable. Joining in 1908, he served the Society actively over many years on many committees, as local representative in Columbus, Ohio and as Faculty Representative at Ohio State University, where he had organized and conducted courses in illuminating engineering for a long period.

Professor Caldwell had attended Cornell University, receiving his master's degree in 1891. Further study, under the Sage Scholarship, was done at the Swiss National Polytechnic during the following years. He then joined the faculty of Ohio State University where he soon became head of the Department of Electrical Engineering. He became Professor Emeritus in 1938.

A member of the I.E.S. Street Lighting Committee since its formation in 1924, he contributed importantly to the economic and humanitarian value of adequate street illumination, in addition to his numerous technical services in this field. He was engineering consultant to the Motor Vehicle Department of the State of Ohio until his retirement.

The *Transactions* of the Illuminating Engineering Society contain many papers and technical discussions by Professor Caldwell, on street lighting, industrial lighting, school lighting and lighting education.

In 1941, he was made Member Emeritus in recognition of his consistent contributions and constructive work both for the Society and the profession of illuminating engineering.

Gaylord B. Buck, Vice-President and General Commercial Manager of the Public Service Company of Colorado, Denver, died August 9 after a brief illness.

Active in the electric utility industry since 1909, Mr. Buck came to Public Service Company in 1924, as sales manager and became general commercial manager in 1928. He was elected to the board of directors in 1932. He became a vice-president of the company in 1937 and vice-president and general commercial manager in 1943. In 1934 Mr. Buck was the recipient of the McGraw Award for cooperation in the industry.

A prominent member of the Rocky Mountain Section, I.E.S., Mr. Buck was official representative to the Society for his company. His son, G. B. (Jim) Buck, II, also of Denver, is Regional Vice President of the I.E.S. Inter-Mountain Region.

IT SEEMS TO ME

School Lighting — June I. E.

All illuminating engineers, and especially those associated with the cold cathode industry, will welcome any study of the merits of cold cathode luminaires. Any analysis, however, to be of value, must consider all pertinent features and should be completely accurate. This, unfortunately, is not the case in Mr. Parsons' article, "Lighting for Classrooms with Nine-Foot Ceilings," in the June 1953 issue of ILLUMINATING ENGINEERING. It is to be wondered why, of all the fixtures available, the cold cathode hairpin fixture was lucky enough to have been chosen by Mr. Parsons for study.

In any fluorescent lamp, there is a relationship between the lumen output and the brightness. This does not check with the figures of lumen output and brightness given by Mr. Parsons. The warm white hairpin lamp has a lumen output of 2300, and its brightness is 1310 ft L. A hairpin lamp of any other color will have a brightness in ft L equal to its lumen output multiplied by $\frac{1310}{2500}$ or 0.57.

The value for illumination is given as an "in service figure." Is it not, therefore, proper to consider brightness figures as maintained values (instead of initial values), or $1310 \times 0.8 = 1050$ ft L?

Mr. Parsons writes of "The wall brightness against which the luminaires are seen . . ." In any normal viewing position, the luminaires are viewed against the ceiling. The brightness ratio between the bare lamps and the adjacent ceiling will be approximately 1310:60 or 22:1.

The cold cathode hairpin luminaire has numerous features in addition to low brightness, which recommend it for use in classrooms. These include low cost, long lamp life, (rated life for the type LP lamp is 15,000 hours and for the type HP lamp 25,000 hours), economical maintenance, uniform illumination distribution and a high vertical component of illumination.

Successful installation of cold cathode hairpin fixtures have been made in schools throughout the country. They have been used in the Detroit schools for several years, and the Detroit school officials have found that these fixtures are highly suitable for classroom illumination. A case has been reported of a group of Detroit Board of Education employees, who had worked in an area with a nine-foot ceiling, illuminated by cold cathode fixtures similar to those discussed in Mr. Parsons' article. When these people were moved to a direct current area, in which incandescent globes were installed, a committee was organized by the employees to protest against the incandescent lighting.

The cold cathode industry has long believed in the establishment of lighting standards and codes. For a standard to be set up on a national scale, considerable care should be shown to make certain that it is based upon properly documented evidence. It is our belief that this is not the case in regard to the I.E.S. School Lighting Standard. Here is one point in question: it is generally agreed that glare and brightness are related to the size and position of the source. This matter is completely ignored in Paragraph 4.2.3.4 of the Standard.

In the researches conducted by L. L. Holladay, W. S. Stiles and B. H. Crawford, it is shown that the ability to see is dependent upon the adaptation brightness. P. Moon and D. E. Spencer, in a paper in the March 1945 issue of the *Journal of the Optical Society of America*, developed the material of the earlier researchers and have shown that the brightness adaptation is almost entirely dependent upon the portion of the visual field imaged upon the fovea (The fovea is usually considered as a circle subtending a diameter of 1.5°). If a child sitting at the rear of a classroom should look up at the ceiling, a portion of the ceiling consisting of a circle approximately 6 inches in diameter will be imaged on the fovea. For the case of a fixture such as a 14-inch globe, as mentioned in Mr.

(Continued on page 19A)

MANUFACTURERS TRUST COMPANY

MONTAGUE STREET, BROOKLYN, N. Y.

Architect—De Young, Moscowitz and Rosenberg, New York, N. Y.
General Contractor—George A. Fuller Company, New York, N. Y.
Utility—Consolidated Edison Company of New York, Inc., New York, N. Y.

In which interior would you prefer to do business? The gloomy one or the bank with the pleasant, inviting atmosphere?

The two principal factors in creating this transformation were: (1) eliminating the old-fashioned screens and (2) installing modern lighting.

Rambusch lighting engineers collaborated with the architects and the utilities engineers in planning a lighting installation which provides forty (40) foot-candles in-service over the working areas—eliminates glare—and does it all without interfering with the architectural integrity of the interior. Fifty-eight (58) Rambusch patented Downlites, each 750-watts capacity, are recessed in the ceiling coffers above richly decorated ceiling plates matching existing decoration. The bronze chandeliers were inconspicuously altered to conceal a number of reflector lamps for general indirect lighting while low wattage, ivory-tinted lamps replaced the glaring exposed lamps.

DESIGNERS • MANUFACTURERS

RAMBUSCH

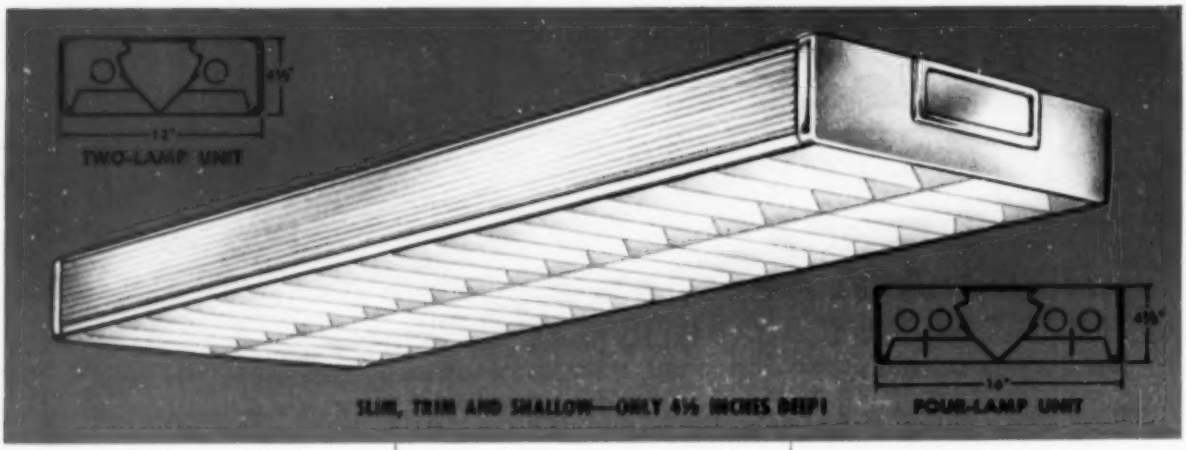
40 WEST 13th STREET, NEW YORK 11, N. Y.

Where the requirements call for high efficiency plus top quality

SPECIFY

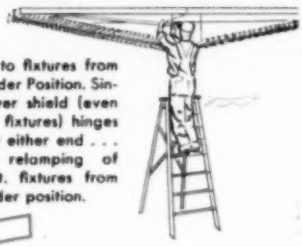
GARCY "STAR-LINER"

LUMINAIRES WITH ALBA-LITE GLASS SIDE PANELS



Sliding Clamp Hangers mean stems can be located anywhere on fixture. Adjustable stem (just turn to raise or lower fixture) means you have both vertical and horizontal alignment. Contractors say Garcy fixtures are least expensive to hang.

Standard "Star-Liner" units have open top. Top reflectors available to give greater downward light.



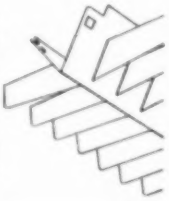
Relamp to fixtures from one Ladder Position. Single louver shield (even on 8-ft. fixtures) hinges down at either end . . . permits relamping of two 8-ft. fixtures from one ladder position.

"STAR-LINER" Luminaires give a modern, built-in look . . . yet can be installed almost overnight! Priced surprisingly low—yet built with quality features for trouble-free service and easy maintenance.

Fixture ends are easy to wire through. Large openings simplify wiring connections for continuous runs; cut installation time.

Shielding angles: Crosswise 31°. Lengthwise 39°. Four-foot or eight-foot units. Standard fluorescent or slimline. Two-lamp or four-lamp units.

Louver cannot rattle or "sing". The V-shaped backbone of the louver exerts pressure on the cross-fins . . . holds them in a vise-like grip that prevents looseness, rattle or "sing". Louver just snaps into place . . . no screws to be manipulated.



GARCY

GARDEN CITY PLATING & MFG. CO.
1760 NORTH ASHLAND AVENUE
CHICAGO 22, ILLINOIS

(*Continued from page 16A*)

Parsons' article, the adaptation brightness would be determined entirely by the fixture brightness, or 1100 ft-L.

When a cold cathode hairpin fixture is used, the adaptation brightness is a function of both the lamp brightness and the ceiling brightness. This is due to the fact that the 1-inch diameter lamp will encompass only a small portion of the fovea and the rest will be covered by the ceiling. The adaptation brightness in this case will be of the order of 300 ft-L. This indicates that even though the source brightness is similar, the adaptation brightness of the globe is nearly four times that of the hairpin fixture.

It is our belief that the figures in Table IV of the Standard are not at all consistent. A louvered fixture using high brightness lamps, can be in agreement with the recommended figures of the Standard, although the area will be visually poor due to the reflected glare from the lamps. The importance of reflected glare is recognized in paragraphs 2.2.2 and A-1.2.1 of the Standard, but completely ignored in the recommendations of Table IV.

We hope that in the future more accurate and complete analysis of cold cathode equipment will be made, and that the Standard will be revised so that its present deficiencies will be corrected.—BRUCE TODD, *President, Fluorescent Lighting Association.*

To the Editor:

My article (June I.E., p. 381) endeavored to compare the published photometric characteristics of the luminaire installed on a 9-foot ceiling with the requirements of the accepted published standard, "The American Standard Practice for School Lighting."

The lumen outputs and associated brightnesses cited were taken from the published data of a lamp manufacturer. Whether the luminaires will appear against the ceiling or against the wall depends on the room dimensions, the mounting height and the position of the eye. Classrooms and study rooms with ceilings down to 9 feet, widths up to 40 feet, and of indeterminate length have been authorized in New York State. For an eye level of 4 feet to 4 feet 6 inches above the floor for a standing pupil, the more distant luminaires suspended a foot or less below the ceiling could well appear against the wall.

I believe it is current practice to state luminaire brightnesses in terms of initial rather than "in service" values. The limiting values for the luminaire given in Table IV of the ASA Standard are commonly so interpreted, comparative data being taken from the photometric test of the luminaire in new, clean condition with carefully photometered standard lamps.

The resultant adaptation brightness from a small diameter line source seen against a lighted background raises an interesting question. The value is undoubtedly lower than if the complete image of the luminaire fell on the fovea, but I question that in this instance a definite value such as 300 footlamberts can be assigned. Moreover, foveal adaptation to the resultant brightness requires fixation of the luminaire and its immediate surroundings. This assumption is not made in glare rating procedures now commonly in use where the line of sight is assumed to be horizontal and the adaptation brightness thus at a fairly low level. On this pattern the brightnesses of the luminaires are then imposed at the various angles with the line of sight to which they occur. Photometric laboratories are now equipped to perform glare rating calculations and data are being published by some luminaire manufacturers. A more accurate determination of my admittedly approximate figure for the glare rating of a 9-foot ceilinged classroom could be obtained.

I made no attempt to defend or criticize the American Standard. While many people in lighting work may have reservations on one or more technical points, this publication's acceptance is attested to by the formidable array of organizations represented on the Sectional Committee and listed in the Foreword. I agree that more stringent brightness limitation requirements in the reflected glare zone are highly desirable as it has been shown elsewhere that reduced visibility from reflected glare wastes a high percentage of the footcandles on the work. In one instance it was shown that by decreasing the light source brightness toward the work from 1200 footlamberts to 200 footlamberts, an improvement in visibility occurs which is comparable to increasing the illumination by almost 50 per cent. This indicates that brightness limitations in the reflected glare zone could advantageously be restricted well below the value produced by so-called low brightness lamps.—J. F. PARSONS, *Niagara Mohawk Power Corp., Buffalo, N. Y.*

Glare and the "Normal" Eye

In view of the commendable current interest in proper distribution of brightness in the field of vision and proper limits on glare within the field of vision, it seems to me that it may be well to emphasize a little more that planning a lighting installation that will suit "everybody," as for example in a large general office, is a fine ideal to be striven toward rather than something that can be fully attained in most cases, because of the differences in individuals. The most that we can hope to do in designing lighting methods or installations is to suit an approximately calculated majority. This is recognized on page 2-33, *I.E.S. Lighting Handbook*, 2nd edition, but there has been so much effort rightly put by researchers into establishing "norms" for various things relating to vision that there is some danger that the extreme differences between eyes will be lost sight of even though some of those differences support thousands in the optical and optometric lines.

Data on sensitivity to glare, obtained from testing large numbers of people, is not as extensive as that relating to visual acuity, for example, but what we have shows a wide variation between individuals. Results obtained by various researchers can not be reduced to a common basis because of lack of uniformity in test conditions.

Luckiesh and Guth in their "B.C.D." research reported in ILLUMINATING ENGINEERING, November 1949, gave the judgments of 50 observers as to the borderline between comfort and discomfort with a circular glare source of a given size in a 10-footlambert field; in other words an appraisal of discomfort glare under the specified test conditions. The highest observer chose a 1600-footlambert source and the lowest 315. As the authors point out: "The variation between individuals is not unexpected nor extraordinary. . . . Contrast sensitivity, for example, has been used as a criterion of retinal sensitivity and has been demonstrated to vary widely for a group of subjects who may be otherwise rated equal and are so called normal on a visual acuity basis."

The historic Pelham Parkway tests made by headlighting committees of I.E.S and S.A.E. reported in I.E.S. *Transactions* for 1919, Vol. XIV, No. 2, used 40 observers and may be rated as a kind of crude test of what later came to be called discomfort glare, as each observer gave his judgment as to what glare he considered tolerable under the night headlighting conditions of the test. The results ranged from .008 to .085 footcandles at the eye.

Prof. A. H. Lauer, now head of the driving research laboratory at Iowa State College, Ames, reported, in the 1936 Year Book of Optometry, results of tests on 1014 commercial drivers ,under uniform conditions, with a "glareometer" which was designed to show the relative ability of the various subjects to see against headlight glare; in this case disability glare. The principle used was to vary the glare until a constantly

(*Continued on page 21A*)

Reception lobby, corridors, and ten private offices at Thew Shovel Company, Lorain, Ohio, are lighted by "Wakefield Geometrics" luminous ceilings that include rigid-arch diffusers of PLEXIGLAS. The ceilings are manufactured by F. W. Wakefield Brass Company, Vermilion, Ohio.

New type of large-area lighting

with **Formed Diffusers** of **PLEXIGLAS**

Here is a new development in the use of PLEXIGLAS acrylic plastic for luminous ceilings. Each of the four-foot-square diffusers in the installation shown above is a shallow *dome*, formed from white translucent PLEXIGLAS. The domed design gives structural rigidity to the panels, making the use of such large diffusers completely practical from the standpoints of safety, ease of handling, and permanence of shape.

Notice how the use of PLEXIGLAS results in uniform, efficient diffusion of light from completely concealed fluorescent lamps. Three lamps are mounted above each panel on separate controls for three levels of illumination, ranging from 50 to 90 footcandles. Diffusion is so complete that panels are illuminated evenly at each level of light intensity.

In addition to formability and efficient diffusion, PLEXIGLAS offers other advantages in lighting—strength, light weight, dimensional stability, and resistance to breakage and discoloration. For better lighting, investigate the use of PLEXIGLAS for luminous ceilings and large-area fixtures. We will be glad to send you illumination data on the installation shown above.

PLEXIGLAS *is a trademark, Reg. U. S. Pat. Off. and other principal countries of the Western Hemisphere.*

CANADIAN DISTRIBUTOR: *Crystal Glass & Plastics, Ltd., 130 Queen's Quay at Jarvis Street, Toronto, Ontario, Canada.*

PLEXIGLAS *is listed in Sweet's Architectural File, Section 6d Ro.*

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

(*Continued from page* 19A)

illuminated test object would just disappear. The results in footcandles at the eye under the test conditions, were 37 maximum and 3 minimum.

Apparently a lot of other mass testing of automobile drivers has been done with "glarometers" but there has unfortunately been a lack of standardization or uniformity of instruments and methods which makes comparison of results obtained by different investigators impossible.

I have recently had access to Research Reports of the Traffic Engineering and Safety Department of the American Automobile Association, Washington, D. C., about some development work on a new "night sight meter" by Earl Allgaier, in charge of driver education work for that Association. This instrument simulates night driving conditions for testing drivers as to night vision both with and without headlight glare. The glare is kept constant and the brightness of a test target is varied, until the point is reached where the observer fails to read the target correctly. The target is a black ring on a white background with one quarter of the ring cut out. The position of the cut out part is varied and the ring exposed a certain number of times per minute. With proper calibration the results can be given in terms of target brightness at which the observer just starts to lose ability to tell the position of the break in the ring. This is also a test for disability glare. The results from testing about 1500 subjects in testing out this meter show about the same wide variations that the previously cited tests showed.

Fortunately in all the before cited tests the extreme results were obtained from a small percentage of the whole but it is well to recognize that there are such extreme cases and to consider how far one should go to satisfy them in planning interior lighting. Also in connection with headlighting and night driving there is a problem yet to be solved as to what limits should be set by employers of drivers, and perhaps in the future by public authorities granting driver licenses, as to ability of a driver to with stand glare.—J. R. CRAVATH (Retired), *2152 Ward St., Berkeley 5, Calif.*

ABOUT PEOPLE

Lester H. Graves, vice president of Curtis Lighting, Inc., has retired from business after 41 years with the company. Mr. Graves is a Fellow and Past-President of I.E.S.

A series of division-wide appointments and assignments have been made by Westinghouse Lamp Division, as announced by **F. M. Sloan,** general manager. **James E. Woodall** has been named to the newly-created post of Manager of Manufacturing; **Elwood W. Noxon,** formerly manager of southern plants, is now manager of northern plants; and **Charles T. Nichols** succeeds Mr. Noxon as manager of southern plants. The position of Manager of Manufacturing Engineering has been established and **William J. Williams,** formerly manager of parts plants, has been appointed to this assignment. **Laurence V. Radtke** has been named manager of quality control. **William C. Kappler** has been appointed works manager at the Richmond Christmas-tree and miniature lamp plant; **J. J. Roskos** will be manager of the Alabama plant at Reform, Ala.; and **Ralph A. Adams** has been named works manager of the Paris plant. **Dr. Arthur W. Wishart** of Fairmont, W. Va., manager of the division's glass plants and **George E. Lambert,** manager of the fluorescent and sealed-beam lamp plant in Fairmont, will continue in their present posts.

The appointment of **L. J. Fitzpatrick** as assistant to F. M. Sloan, general manager of the lamp division of Westinghouse Electric Corp., was also announced.

J. E. Nichols, Director of Industrial Safety for Reynolds Metals Co., Richmond, Va., has accepted membership on the Board of Directors of the National Society for the Prevention of Blindness, as part of the society's campaign to stop industrial eye accidents.

The officers of the American Society for Testing Materials for the coming year were announced at the society's annual meeting July 3 in Atlantic City. President is **Dr. Leslie C. Beard, Jr.,** Assistant Director of Socony-Vacuum Laboratories, New York, N. Y. Newly elected Vice-President is **Claire H. Fellows,** Director of the Engineering Laboratory and Research Department of The Detroit Edison Co., Detroit. Members of the Board of Directors, elected for three-year terms, are **Neil A. Fowler,** Director of Sales and Research, General Box Co., Des Plaines, Ill.; **Richard T. Kropf,** Vice-President, Industrial Thread Division, Belding Heminway, Corticelli, New York, N. Y.; **Theodore E. Olt,** Director, Research Laboratories, Armco Steel Corp., Middletown, Ohio; **John R. Townsend,** Director of Material and Standards Engineering, Sandia Corp., Albuquerque, N. M.; and **Kenneth B. Woods,** Associate Director, Joint Highway Research Project and Professor of Highway Engineering, Purdue University, Engineering, Purdue University, Engineering Experiment Station, Lafayette, Ind.

The formation of two new departments, a separate Specialty Transformer Department and a Ballast Department has been announced by General Electric Co.'s Component Products Division. **Carl H. Rinne,** formerly manager of the Specialty Transformer and Ballast Department, has been named general manager of the Specialty Transformer Department which will have its headquarters at Fort Wayne, Indiana. General manager of the new Ballast Department will be **Charles P. Hayes,** with headquarters in Danville, Ill., where the ballast plant is located. Concurrent with their appointments, the new managers announced the following staffs for their departments: Ballast Department—**Gordon C. Harvey,** manager—engineering; **Elmer F. Paul,** manager—manufacturing and relations; **Edmund C. Schorr,** manager—marketing; and **Ralph M. Hensler,** manager—finance. Specialty Transformer Department—**Everett J. Thomas,** manager—engineering; **Richard J. Keyser,** manager—manufacturing; **Joseph P. Coughlin,** manager—marketing; **Eugene H. Henry,** manager—finance; **Stephen R. Capps,** manager—employee relations.

Two research chemists of the Corning Glass Work will be awarded John Price Wetherill Medals by the Franklin Institute of the State of Pennsylvania for their discovery of a photosensitive glass process. The Institute will award **Dr. S. Donald Stookey** and **Dr. Robert H. Dalton** the medals on the occasion of its annual Medal Day ceremonies in Franklin Hall, October 21. The Corning men are being honored "In consideration of their work in leading to and developing a practical and commercially acceptable method for producing photographs in glass and opalescent designs in glass by photosensitive processes," according to the citation accompanying the awards.

Walter S. Stanton has been appointed architectural representative by the Cold Cathode Lighting Corp., Long Island City, N. Y. Mr. Stanton was formerly associated with the late Dan Everett Ward, architect for the Metropolitan Life Insurance Co., and subsequently with the Johns-Manville Sales Corp., as architectural representative.

(*Continued on page* 45A)

Supt. Frank D. Lawler, whose School Building Committee insisted on the most comfortable lighting, reports . . . . . .

. . "We wanted the best lighting available so we installed Westinghouse CD Luminaires"

"When we built the new Mary P. Hinsdale School, our School Building Committee insisted on the best and most comfortable lighting available. Westinghouse CD's have certainly lived up to those expectations," reports Superintendent Frank D. Lawler, Town of Winchester, Winsted, Conn.

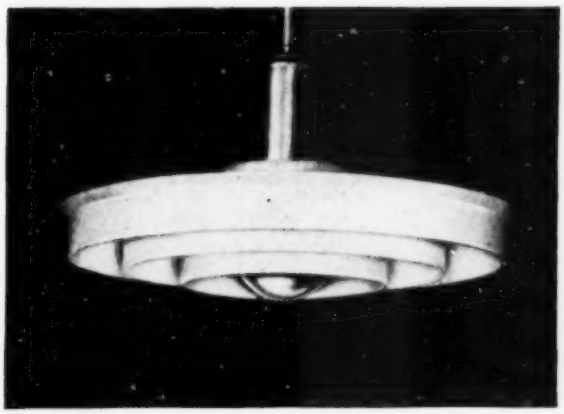
The Westinghouse CD luminaire, with plastic shielding, provides a semi-indirect lighting system. Installed in continuous rows, as is shown in this classroom, the result is an almost glareless system of comfortable lighting. The entire ceiling becomes a part of the lighting system; all lamps are completely shielded.

What's more, the Westinghouse CD makes an attractive addition to the classroom. Its design simplicity fits as a natural part of the background in modern interiors.

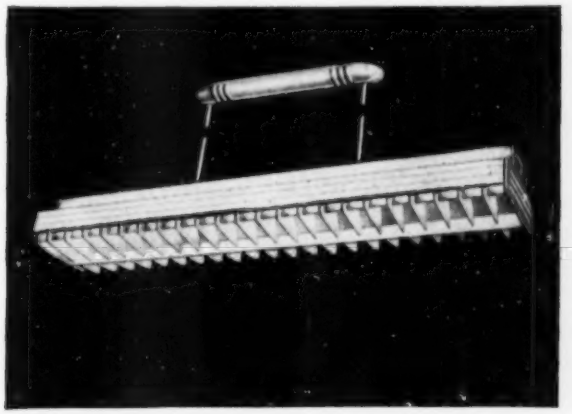
The superintendent further reports, "Our teachers and the school board are very pleased with the new lighting system. Their enthusiasm and that of our parents will undoubtedly influence both future construction and any remodeling of present classrooms."

For other installation methods, get B-4556, "The ABC Plan for School Lighting". Meantime—*look for this seal on your electrical contractor's guarantee. He installs them—we back him up.* Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa. J-04340-A

And to meet other requirements . . .



Low FIRST cost Concentric Ring incandescent luminaires meet quality lighting requirements on limited funds. Metal rings shield silvered bowl lamps, eliminating glare and shadows.



CC Luminaires mean economy in fluorescent lighting. Low in initial cost—low in maintained cost. CC with X° louver design meets A.S.A. school standards.

YOU CAN BE **SURE**... IF IT'S
Westinghouse

SUSTAINING MEMBERS

Acme Electric Corp.
Cuba, N. Y. *J. A. Comstock*

Advance Transformer Company
1122 W. Catalpa Ave., Chicago 40, Ill.
A. E. Feinberg

Alabama Power Co.
Birmingham, Ala. *George L. Morris*

All Bright Electric Products Co.
3917-25 N. Kedzie Ave., Chicago 18, Ill.
Max Klein

Aluminum Company of America
Gulf Building, Pittsburgh 19, Pa. *C. Braglio*

Amalgamated Electric Corp., Ltd.
384 Pape Ave., Toronto, Ont., Canada
W. A. Dalrymple

American Concrete Corp.
5092 N. Kimberly Ave., Chicago 30, Ill.
J. W. Lewis

American Fluorescent Corp.
1234 N. Paulina St., Chicago 22, Ill.
William Rusnak

American Sterilizer Co.
Erie, Pa. *Horace Wm. Alexander*

Appleton Electric Co.
1701-1729 Wellington Ave., Chicago 13, Ill.
Nils A. Tornblom

Arkansas Power & Light Co.
Simmons National Bldg., Pine Bluff, Ark.
Max Sudduth

The Art Metal Co.
1814 E. 40th St., Cleveland 3, Ohio
George E. Glatthar

Atlantic City Electric Co.
1600 Pacific Ave., Atlantic City, N. J.
John B. Taylor

Benjamin Electric Mfg. Co.
Des Plaines, Ill. *Benjamin S. Benson*

Blue Ridge Glass Corp.
P.O. Box 631, Kingsport, Tenn. *James Herbert*

Board of Water and Electric Light Commissioners
116 W. Ottawa St., P.O. Box 570
Lansing 3, Mich. *John D. Malnight*

Boston Edison Co.
39 Boylston St., Boston 12, Mass. *R. B. Brown, Jr.*

Branham, Marock & Duepner, Inc.
7020 Walker St., St. Louis Park
Minneapolis 16, Minn. *Cecil H. Branham*

British Columbia Electric Rwy. Co., Ltd.
570 Dunsmuir St., Vancouver, B. C., Canada
H. N. Walters

Brockton Edison Co.
36 Main St., Brockton 67, Mass. *W. A. Forbush*

California Electric Power Co.
P.O. Box 512, Riverside, Calif. *Robert W. Dowd*

Calpa Products Co.
5420-28 Paschall Ave., Philadelphia 4, Pa.
Paul C. Calissi

Cambridge Electric Light Co.
46 Blackstone St., Cambridge 39, Mass.
Reginald H. Bowman

Canadian General Electric Co., Ltd.
212 King St., Toronto, Ont. *R. M. Love*

Canadian Laco Lamps, Ltd.
745 Guy St., Montreal, Que. *J. Thomas*

Canadian Line Materials, Ltd.
Postal Station H., Toronto 13, Ont., Canada
L. E. Messinger

Canadian National Exhibition Association
Exhibition Park, Toronto, Ont. *H. E. McCallum*

Central Hudson Gas and Electric Corp.
50 Market St., Poughkeepsie, N. Y. *H. E. Dexter*

Central Illinois Light Co.
316 Jefferson Ave. S., Peoria 2, Ill. *W. F. Bolle*

Central Illinois Public Service Co.
607 E. Adams St., Springfield, Ill. *B. L. Palm*

Central Louisiana Electric Co., Inc.
P.O. Box 1096, Lafayette, La. *J. R. Gaugler*

Central Maine Power Co.
9 Green St., Augusta, Maine *Roland W. Hess*

Central Power & Light Co.
P.O. Box 2121, Corpus Christi, Texas
James M. Williams

Champion Lamp Works Div. of Consolidated Electric Lamp Co.
600 Broad St., Lynn, Mass. *Ellery H. Raddin*

Cincinnati Gas & Electric Co.
Fourth & Main Sts., Cincinnati 1, Ohio
J. R. Hartman

City of Burbank, California Public Service Dept.
164 W. Magnolia Boulevard, Burbank, Calif.
Ralph Foy

City of Glendale Public Service Dept.
119 N. Glendale Ave., Glendale 6, Calif.
L. W. Grayson

City of Riverside Light Dept.
P.O. Box 826, Riverside, Calif. *A. J. Kennedy*

City of Seattle, Dept. of Lighting
1015 Third Ave., Seattle 4, Wash. *P. C. Spowart*

City of Tacoma, Light Division
402 City Hall, Tacoma 2, Wash. *Roy H. Weston*

The Cleveland Electric Illuminating Co.
75 Public Square, Cleveland 1, Ohio
R. C. Hienton

Clyde Porcelain Steel Corp.
2211 Birdseye St., Clyde, Ohio *W. F. White*

C. W. Cole & Co., Inc.
320 E. 12th St., Los Angeles 15, Calif.
Russell W. Cole

Colonial Premier Corp.
466 W. Superior St., Chicago 10, Ill.
Richard Weis

Columbia Electric & Mfg. Co.
Box 2180, Spokane, Wash. *Walter A. Toly*

Commercial Light Co.
841 W. Washington Blvd., Chicago, Ill.
Michael R. Fine

Commonwealth Edison Co.
72 W. Adams St., Chicago 90, Ill.
G. K. Hardacre

Compco Corporation
2251 W. St. Paul, Chicago 47, Ill.
Lawrence H. Wrobel

Connecticut Light & Power Co.
P.O. Box 2010, Hartford 1, Conn. *Robert G. Ely*

Consolidated Edison Co. of N. Y., Inc.
4 Irving Place, New York 3, N. Y. *C. Miller*

Consolidated Gas, Electric Light & Power Co. of Baltimore
100 W. Lexington St., Baltimore 1, Md.
M. C. Albrittain

Consumers Power Co.
212 Michigan Ave. W., Jackson, Mich. *D. E. Karn*

Consumers Public Power District
1452 25th Ave., Columbus, Nebr. *W. H. Sinks*

Continental Electrical Construction Co.
3540 Southport Ave., Chicago 13, Ill. *Leo W. Witz*

Corning Glass Works
Corning, N. Y. *A. S. Tyler*

Coyne Electrical School, Inc.
500 So. Paulina St., Chicago 7, Ill. *John Hanan*

Crescent Electric Supply Co.
765 Iowa St., Dubuque, Iowa *Titus B. Schmid*

Crouse-Hinds Co.
Syracuse 1, N. Y. *A. H. Clarke*

Crouse-Hinds Co. of Canada, Ltd.
7 Labatt Ave., Toronto, Ont. *F. R. Jeffery*

Curtis Lighting, Inc.
6135 W. 65th St., Clearing Station
Chicago 38, Ill. *Darwin Curtis*

Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave., Leaside, Toronto 12, Ont.
H. L. Wright

Cutler Light Manufacturing Co.
2026-28 N. 22nd St., Philadelphia 21, Pa.
Robert T. Cutler

Dallas Power & Light Co.
1506 Commerce St., Dallas 1, Texas *W. G. Moore*

Day-Brite Lighting, Inc.
5401 Bulwer St., St. Louis 7, Mo. *D. J. Biller*

The Dayton Power & Light Co.
25 No. Main St., Dayton, Ohio *H. S. Nonneman*

Dazor Manufacturing Corp.
4483 Duncan Ave., St. Louis 10, Mo. *P. L. Read*

Delaware Power & Light Co.
600 Market St., Wilmington 99, Del.
W. A. F. Pyle

Dept. of Water & Power, City of Los Angeles, Bureau of Power & Light
Box 3669, Terminal Annex, 207 So. Broadway
Los Angeles 54, Calif. *William S. Peterson*

Detroit Edison Co.
2000 Second Ave., Detroit 26, Mich. *L. E. Taylor*

Detroit Electrical Contractors Association
940 Book Building, Detroit 26, Mich.
Carl J. Schoeninger

Detroit Steel Products Co.
2250 E. Grand Blvd., Detroit 11, Mich.
W. Clifton Randall

E. I. duPont de Nemours & Co., Inc. (Fabrics & Finishes Div.)
Wilmington 98, Del. *S. W. Quisenberry*

E. I. duPont de Nemours & Co., Inc. Polychemicals Dept.
Wilmington 98, Del. *R. E. Leary*

Duquesne Light Co.
435 Sixth Ave., Pittsburgh 19, Pa. *G. W. Ousler*

Duray Fluorescent Mfg. Company
3318 W. Montrose Ave., Chicago 18, Ill.
Ludwig Dannenberg

Duro Test Corp.
2321 Hudson Blvd., North Bergen, N. J.
James L. Cox

Eastern Fixture Co., Inc.
170 Vernon St., Boston 20, Mass. *Louis Gilman*

(Continued on page 27A)

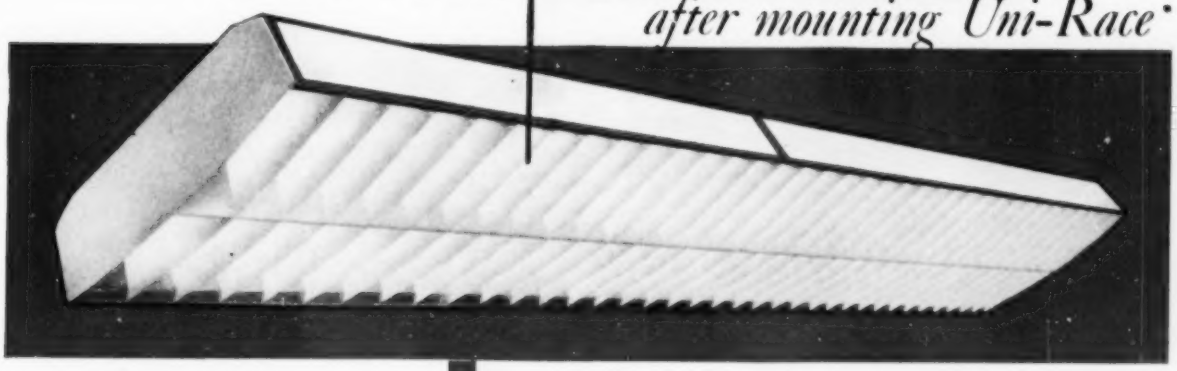
(*Note:* Names of Official Representatives appear in italics.)

YOUR HANDS

are all you need to install the new Gibson

ortho-77
Reg. U.S. Pat. Off. Applied For

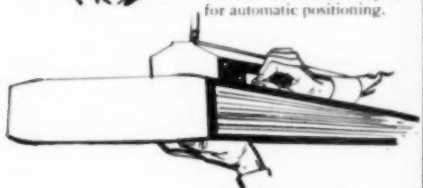
after mounting Uni-Race



Patent Applied for

STEP 1: Mount UNI-RACE, a lightweight, rigid, open raceway.

STEP 2: Hang fixture into slots on UNI-RACE spaced for automatic positioning.



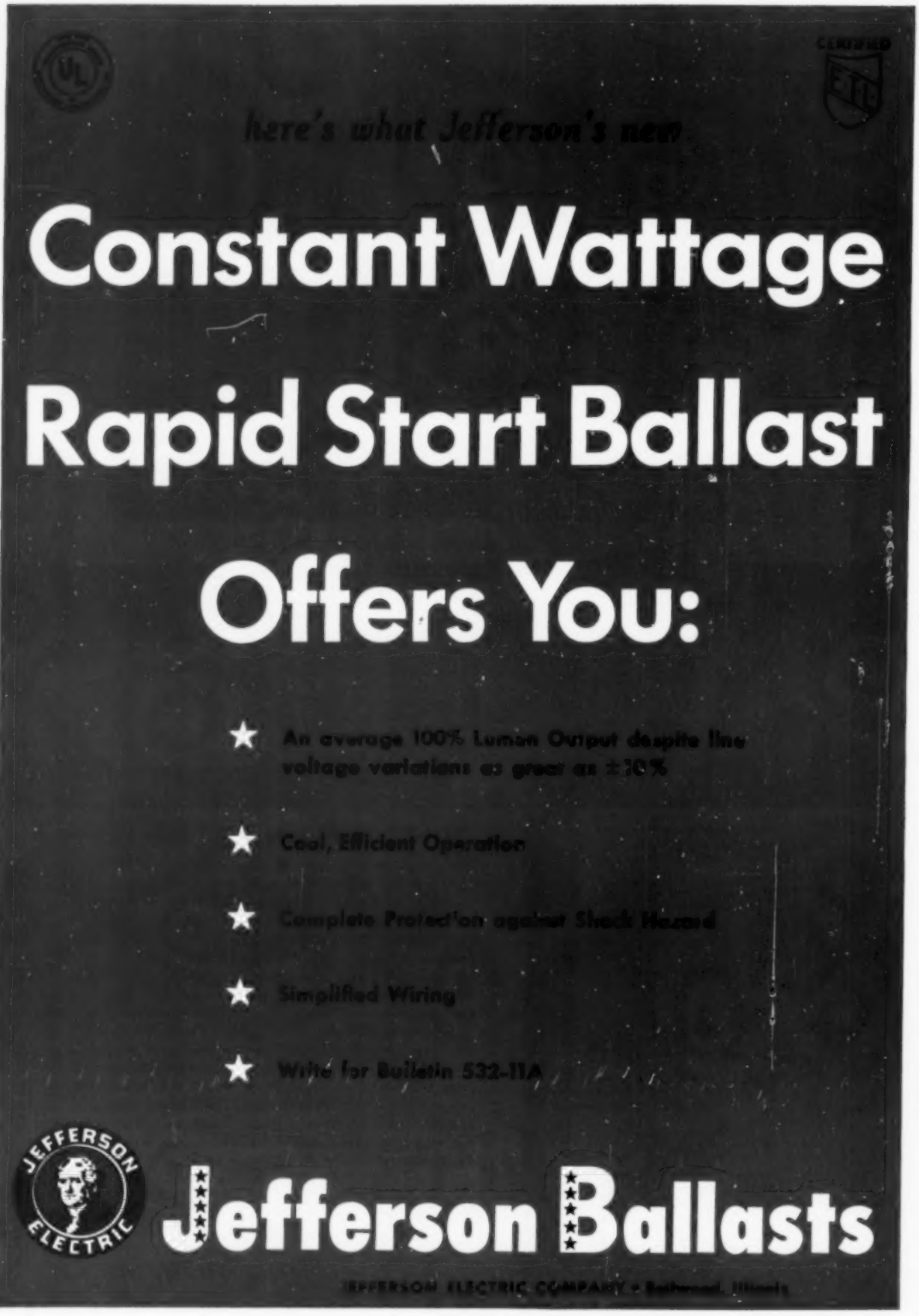
STEP 3: Close and tighten take-up screw by hand.

THERE IS NOTHING LIKE IT . . .

So revolutionary in design is the new Gibson ORTHO-77 it is the talk of lighting men everywhere. A special unique raceway (UNI-RACE) provides POSITIVE ALIGNMENT, AUTOMATIC SPACING, FIXED POWER SOURCE, and a RIGID CHANNEL ANCHOR for all ORTHO-77 models. Light in weight, it is readily accessible and easily mounted. A special receptacle permits wire-in in a matter of minutes without tools. Lighting levels can be raised from two to four lite on the same UNI-RACE, or fixtures mounted on a continuous UNI-RACE at spaced intervals can quickly be made continuous later. The fixture is never defaced . . . only the UNI-RACE, a low cost easily replaceable part. The ORTHO-77 is a completely INTEGRATED UNIT built around V-TYPE GIRDER CONSTRUCTION to assure rigidity and permanence of shape. These are just a few of the many features of this phenomenal new concept of design outlined in Bulletin ORT-101. By all means write for it today.

GIBSON *Manufacturing Co.*

1919 PIEDMONT CIRCLE, N. E. • ATLANTA, GEORGIA


here's what Jefferson's new
Constant Wattage
Rapid Start Ballast
Offers You:
★ An average 100% Lumen Output despite line voltage variations as great as ±10%
★ Cool, Efficient Operation
★ Complete Protection against Shock Hazard
★ Simplified Wiring
★ Write for Bulletin 532-11A
JEFFERSON ELECTRIC
Jefferson Ballasts
JEFFERSON ELECTRIC COMPANY • Bellwood, Illinois

(Continued from page 24A)

East Side Metal Spinning & Stamping Corp.
1301 Elizabeth Ave., W., Linden, N. J.
M. A. Kremer

Ebasco Services, Inc.
2 Rector St., New York 6, N. Y. *P. D. Brooks*

Efengee Electrical Supply Co.
949 W. Chicago Ave., Chicago 22, Ill. *Lee Mirus*

Electrical Information Publications, Inc.
20 N. Carroll St., Madison, Wis.
Lewis E. Johnston

Electric Supply Corporation
701 W. Jackson Blvd., Chicago 6, Ill.
G. M. Marks

Electrical Products Corporation
1100 North Main St., Los Angeles 12, Calif.
L. A. Rice

Electrical Testing Laboratories, Inc.
79th St. & East End Ave., New York 21, N. Y.
W. F. Little

Electro Silv-A-King Corporation
2000 West Fulton St., Chicago 12, Ill.
L. K. Schoenbrod

Electrolier Mfg. Company, Ltd.
5849 Boyer St., Montreal, Que., Canada
John Issenman

Englewood Electrical Supply Co.
5801-03 So. Halsted St., Chicago, Ill. *Ray O'Leary*

Enterprise Electric Co.
6507 Euclid Ave., Cleveland, Ohio *William S. Fell*

Esty Manufacturing Company
1231 W. Monroe St., Chicago 6, Ill.
Ben Trossman

Ever-Brite Products Corp.
1629 Milwaukee Ave., Chicago 47, Ill.
Jack Lipschultz

Fitchburg Gas & Electric Light Co.
537 Main St., Fitchburg, Mass. *A. G. Neal*

Florida Power & Light Co.
Box 3100, Miami 30, Fla. *C. B. Vick*

Fluorescent Equipment & Mfg. Co.
5105 Cowan Ave., Cleveland 4, Ohio
Leonard S. Freeman

Fluorescent Fixtures of Calif.
3320 18th St., San Francisco 10, Calif.
Ernest O. Anders

Fluores-O-Lite Co.
Evans Terminal, No. Broad St., Hillside, N. J.
Meyer H. Silverman

The Fostoria Pressed Steel Corp.
Fostoria, Ohio *E. L. Bates*

H. A. Framburg & Co.
3320-28 Carroll Ave., Chicago 24, Ill.
Stanley A. Framburg

The France Mfg. Co.
10325 Berea Rd., Cleveland 2, Ohio *E. L. Walter*

The Frankelite Co.
1425 Rockwell Ave., Cleveland 14, Ohio
Dave Frankel

Franklin Design Service
Division of Safeway Stores, Inc.
4th & Jackson Sts., P.O. Box 660
Oakland 4, Calif. *T. E. Rinehart*

The Frink Corporation
27-01 Bridge Plaza North
Long Island City, N. Y. *Theo. J. Brassel, Jr.*

Fullerton Manufacturing Corp.
17 Chestnut St., South Norwalk, Conn.
Lawson Fullerton

Gallagher-O'Brien Electric Co., Inc.
915 W. North Ave., Chicago 22, Ill.
Frank A. Gallagher

Garden City Plating & Mfg. Co.
1750 No. Ashland Ave., Chicago 22, Ill.
G. G. Harney

General Electric Co., Apparatus Dept.
River Works, 920 Western Ave.
West Lynn, Mass. *W. J. Fleming*

General Electric Co., Lamp Dept.
Nela Park Cleveland 12, Ohio *Willard C. Brown*

General Electric Supply Company
A Division of General Electric Distributing Corp.
1260 Boston Ave., Bridgeport 9, Conn.
W. W. Booth

General Fireproofing Co.
Dennick Ave., Youngstown, Ohio *J. A. Saunders*

General Lighting Products Co.
468 Frelinghuysen Ave., Newark 5, N. J.
Nathan H. Eglowstein

General Outdoor Advertising Co., Inc.
515 So. Loomis St., Chicago, Ill. *C. E. Freeland*

The Georgia Power Co.
Electric Building, Atlanta 1, Ga.
Charles A. Collier

Gibson Manufacturing Co.
1919 Piedmont Circle N. E., Atlanta, Ga.
R. R. Gibson

Gill Glass & Fixture Co.
Amber & Tioga Sts., Philadelphia 34, Pa.
C. A. Gill

Gillinder Brothers, Inc.
Erie & Liberty Sts., Port Jervis, N. Y.
J. Fletcher Gillinder

Globe Lighting Products Co., Inc.
1710 Flushing Ave.,Brooklyn 6, N. Y.
Isidor Rosenblatt

Godfrey and Wing, Inc.
2110 Superior Ave., Cleveland 14, Ohio
C. G. Wing

Golde Manufacturing Co.
4888 N. Clark St., Chicago 40, Ill. *E. W. Goldberg*

Graybar Electric Co., Inc.
420 Lexington Ave., New York 17, N. Y.
Raymond C. Kinney

Great Northern Mfg. Co.
4221 W. Harrison St., Chicago 24, Ill. *D. J. Epp*

Guardian Light Company Inc.
301 Lake St., Oak Park, Ill. *W. S. Akely*

Gulf States Utilities Co.
Box 2951, Beaumont, Texas *Clarence Barron*

The Edwin F. Guth Co.
2615 Washington Ave., St. Louis 3, Mo.
Fred E. Guth

The Hankins Container Co.
3044 W. 106th St., Cleveland 11, Ohio
Ray T. White

Hartford Electric Light Co.
266 Pearl St., Hartford 3, Conn. *Victor Ouellette*

Hawkins Electric Co.
1447 Washington Blvd., Chicago 7, Ill *R. R. Hill*

Holdenline Co.
2301 Scranton Rd., Cleveland 13, Ohio
H. E. Ingraham

Hollywood Wholesale Electric Co.
6820 Romaine St., Hollywood 38, Calif.
James H. Diffenwierth

Holophane Company, Inc.
342 Madison Ave., New York 17, N. Y.
H. L. Logan

Home Light & Power Co.
810 Ninth St., Greeley, Colo. *C. Gilbert Dressor*

House-O-Lite Corporation
2430 S. Ashland Ave., Chicago 8, Ill.
Jack R. Stone

Hub Electric Company
2219 W. Grand Ave., Chicago 12, Ill.
I. M. Fixman

Hubbard and Company
6301 Butler St., Pittsburgh 1, Pa. *C. C. Warne, Jr.*

Hydro-Electric Power Comm. of Ontario
620 University Ave., Toronto, Ont. *R. L. Hearn*

Hyland Electrical Supply Co.
700 West Jackson Blvd., Chicago, Ill.
Charles K. Lambka

Illinois Power Co.
154 East Main St. (L, Box 511B),
Decatur 70, Ill. *Allen Van Wyck*

Illuminating Engineering Co.
2347 E. Nine Mile Road, Hazel Park, Mich.
Bert C. Pretzer

Interstate Power Co.
1000 Main St., Dubuque, Ia. *R. C. Halcombe*

Iowa Electric Light & Power Co.
Box 351, Cedar Rapids, Ia. *Sutherland Dows*

Iowa-Illinois Gas & Electric Co.
United Light Bldg., Davenport, Iowa
John M. Hollingsworth

Iowa Power and Light Co.
312 Sixth Ave., Des Moines 3, Iowa
N. Bernard Gussett

Iowa Public Service Co., East Div.
400 Commercial St., Waterloo, Iowa
C. R. Wagoner

Iowa Public Service Co., Sioux City Division
P.O. Box 778, Sioux City 4, Iowa *C. R. Tracy*

Jefferson Electric Co.
Bellwood, Ill. *L. Maurer*

Jersey Central Power & Light Co.
501 Grand Ave., Asbury Park, N. J. *D. L. Douglas*

Jeryl Lighting Products Inc.
42 West Cermak Rd., Chicago, Ill.
Charles Meyerson

Joleco Corporation
2513 Baldwin St., St. Louis, Mo. *George Ledbetter*

Jones Metal Products Co.
West Lafayette, Ohio *H. Boyer*

Joslyn Mfg. & Supply Co.
3700 So. Morgan St., Chicago 9, Ill. *J. H. Fahey*

Kansas City Power & Light Co.
P.O. Box 679, Kansas City 10, Mo.
John M. Arthur, Jr.

Kansas Gas & Electric Co.
P.O. Box 208, Wichita, Kans. *H. W. Hobson*

The Kayline Company
2480 E. 22d St., Cleveland 15, Ohio *M. A. Eskins*

Kelso-Burnett Electric Co.
223 W. Jackson Blvd., Chicago 6, Ill.
Sigmund A. Hollinger

Kerrigan Iron Works, Inc.
1033 Herman St., Nashville, Tenn. *G. E. Daniels*

Keystone Electric Manufacturing Co.
2228-36 E. Tioga St., Philadelphia 34, Pa.
Leonard M. Siegel

The Kirlin Company
3435 E. Jefferson Ave., Detroit 7, Mich.
Ivan Kirlin

Kopp Glass, Inc.
Swissvale, Pa. *F. C. Ashe*

Morris Kurtzon, Inc.
1420-30 So. Talman Ave., Chicago 8, Ill.
David Koch

The La Salle Lighting Products, Inc.
145 Seneca St., Buffalo 3, N. Y.
Richard C. Piper, Jr.

The Leeds & Northrup Co.
4901 Stenton Ave., Philadelphia 44, Pa.
Dr. R. C. Machler

Libbey-Owens-Ford Glass Co., Plaskon Division
2112-24 Sylvan Ave., Toledo, Ohio
Dr. M. H. Bigelow

Light Control Company
3217 Casitas Ave., Los Angeles 26, Calif.
Stanley E. Lindahl

(Continued on page 28A)

(Continued from page 27A)

Lighting Products, Inc.
2259 W. Park Ave., Highland Park, Ill.
D. E. Dunne

Lightolier Co.
11 East 36th St., New York 16, N. Y. *H. Stollnitz*

Line Material Co., Division of McGraw Electric Co.
800 North 8th St., Milwaukee 1, Wis. *M. C. Harsh*

Litecontrol Corp.
36 Pleasant St., Watertown 72, Mass.
Paul H. Lamson

Lithonia Lighting Products Co., Inc.
Lithonia, Ga. *Robert J. Freeman*

Louisiana Power & Light Co.
142 Delaronde St., Station "A,"
New Orleans, La. *C. L. Osterberger*

Luminator, Inc.
120 N. Peoria St., Chicago 7, Ill.
Albert L. Arenberg

Lynn Gas & Electric Co.
90 Exchange St., Lynn, Mass. *James A. Cook*

Macbeth Corp.
P.O. Box 950, Newburgh, N. Y. *Norman Macbeth*

Major Equipment Company Inc.
4603-19 Fullerton Ave.,Chicago, Ill.
Ross O Major

Malden Electric Co.
157 Pleasant St., Malden, Mass.
Warren K. Lawellen

Markel Electric Products, Inc.
145 E. Seneca St., Buffalo 3, N. Y.
Morris L. Markel

Markstone Manufacturing Co.
2460 W. George St., Chicago, Ill. *Martin Schwartz*

Marvin Manufacturing Co.
3071 E. 12th St., Los Angeles 23, Calif.
Carl O. Anderson

La Cie Martineau Electrique Ltee.
24 rue du Roi, Quebec, Canada *Henri Martineau*

Metalcraft Products Co., Inc.
Masher & Lippincott Sts., Philadelphia 33, Pa.
Nathan Bloom

Metropolitan Edison Co.
412 Washington St., Reading, Pa.
T. O. McQuiston

Metropolitan Electrical Supply Co.
20 N. Jefferson St., Chicago 6, Ill. *Fred Pedrigi*

Midwest Chandelier Co.
15th & Gentry Sts., No. Kansas City 16, Mo.
Sidney Lefkovitz

The Miller Co.
Meriden, Conn. *G. W. Beals*

Mississippi Glass Co.
88 Angelica St., St. Louis 7, Mo. *Reed Muir*

Mississippi Power Co.
Gulfport, Miss. *R. M. Shearer*

Mississippi Power & Light Co.
Lampton Building, Jackson, Miss. *B. M. Davis*

Mitchell Manufacturing Company
2525 Clybourn Ave., Chicago 14, Ill.
Bernard Mitchell

Mitchell Manufacturing Co., Ltd.
19 Waterman Ave., Toronto 13, Ont.
J. E. Landers

Modern Light Company
7809 Maplewood Industrial Court,
Maplewood 17, Mo. *J. E. Baker*

Modern Light & Equipment Co.
3812 S. Wabash Ave., Chicago, Ill.
M. L. Offenberg

Moe-Bridges Corp.
1415 Illinois Ave., Sheboygan, Wis.
Frank J. Marriet

Moe Light, Inc.
700 Oak St., Fort Atkinson, Wis. *Stanley Warner*

Monroe Electric Co.
157 W. Ontario St., Chicago 10, Ill. *Albert Kahn*

Montana-Dakota Utilities Co.
831 Second Ave. So., Minneapolis 2, Minn.
W. L. Hayes

The Montana Power Co.
40 East Broadway, Butte, Mont. *D. J. McGonigle*

Mountain States Power Co.
236 Lyon St., Albany, Ore. *A. T. Peterson*

Municipal Light and Power Dept.
City of Pasadena, California, 302 City Hall
Pasadena 1, Calif. *T. M. Goodrich*

Mutual Sunset Lamp Mfg. Co., Inc.
540 Empire State Bldg., New York 1, N. Y.
Morris Thau

The Narragansett Electric Co.
49 Westminster St., Providence 1, R. I.
C. R. Broadhead

National Chemical & Manufacturing Co.
Luminall Paint Div.
3617 So. May St., Chicago 9, Ill.
John Marshall Ziv

New Bedford Gas & Edison Light Co.
695 Purchase St., New Bedford, Mass.
W. S. Fenstermacher

New Orleans Public Service, Inc.
317 Baronne St., New Orleans, La. *S. L. Drumm*

New York State Electric & Gas Corp.
62 Henry St., Binghamton, N. Y.
Earle C. Edwards

Niagara Mohawk Power Corp.
300 Erie Blvd. W., Syracuse 2, N. Y.
R. H. Stratton

Northern Electric Co., Ltd.
1620 Notre Dame St., West, Montreal, Quebec
F. P. Labey

Northern Indiana Public Service Co.
5265 Hohman Ave., Hammond, Ind.
J. C. Sackman

Northern Light Company
1657 No. Water St., Milwaukee 2, Wis.
Fred Cramer

Northern States Power Co.
Minneapolis 2, Minn. *Carl T. Bremicker*

Ohio Edison Co. (Akron Div.)
Akron 8, Ohio *C. L. Dunn*

The Ohio Power Co.
301-315 Cleveland Ave., S. W.
Canton 2, Ohio *R. W. Osterholm*

The Ohio Public Service Co.
P.O. Box 6058, Cleveland 1, Ohio *C. L. Dunn*

Oklahoma Gas & Electric Co.
Box 1498, Oklahoma City 1, Okla. *E. W. Gray*

Omaha Public Power District
720 Electric Bldg., Omaha 2, Neb. *E. E. Schwalm*

Pacific Gas & Electric Co.
245 Market St., San Francisco 6, Calif.
O. R. Doerr

Pacific Power & Light Co.
522 Public Service Bldg., Portland 4, Ore.
C. A. Root

Peerless Electric Limited
5585 Fullum, Montreal 36, Que. *L. A. Van Duzer*

Wm. Penn Fluorescent Light Mfg. Co.
1429 So. 23rd St., Philadelphia 46, Pa.
Pat Pedicone

Pennsylvania Electric Co.
535 Vine St., Johnstown, Pa. *Frank R. Knowles*

Pennsylvania Power Co.
19 E. Washington St., New Castle, Pa.
P. G. Dingledy

Pennsylvania Power & Light Co.
901 Hamilton St., Allentown, Pa. *J. M. Stedman*

Pennsylvania Wire Glass Co.
1612 Market St., Philadelphia 3, Pa.
Dr. Frank W. Preston

The Perfectite Company
1457 E. 40th St., Cleveland, Ohio
Joseph L. Jaffe, Jr.

Philadelphia Electric Co.
1000 Chestnut St., Philadelphia 5, Pa.
R. G. Rincliffe

Philadelphia Electrical & Mfg. Co.
1228-36 N. 31st St., Philadelphia 21, Pa.
R. A. Manwaring

Phoenix Glass Co.
Monaca, Pa. *D. G. Cameron*

Pierce Electric Co.
367 W. Adams St., Chicago 6, Ill. *John H. Pierce*

Pittsburgh Corning Corp.
1 Gateway Center, Pittsburgh, Pa.
Robert W. McKinley

Pittsburgh Plate Glass Co.
Grant Bldg., Pittsburgh 19, Pa. *R. B. Tucker*

Pittsburgh Reflector Co.
403-411 Oliver Bldg., Pittsburgh 22, Pa.
H. C. Zinsmeister

Portland General Electric Co.
Electric Bldg., Portland 5, Ore. *T. W. Fitch*

The Potomac Edison Co.
55 E. Washington St., Hagerstown, Md.
S. S. Bradford

Powerlite Devices, Limited
1870 Davenport Rd., Toronto 9, Ont.
M. B. Hastings

Progressive Products Co., Inc.
6615 Milwaukee Ave., Chicago 31, Ill.
E. George Goddard

Pryne & Co., Inc.
P.O. Box 698, Pomona, Calif. *Roger W. Holston*

Public Service Co. of Colorado
900 Fifteenth St., Denver, Colo. *G. B. Buck*

Public Service Co. of Indiana, Inc.
1000 E. Main, Plainfield, Ind. *Robert McMurray*

Public Service Co. of Oklahoma
Box 201, Tulsa 2, Okla. *C. N. Robinson*

Public Service Electric & Gas Co.
80 Park Place, Newark 2, N. J. *H. P. J. Steinmetz*

Puget Sound Power & Light Co.
860 Stuart Bldg., Seattle 11, Wash.
Frank McLaughlin

Quadrangle Mfg. Co.
52 So. Peoria St., Chicago 7, Ill.
Dwight E. Worrell

Quaker City Electric Mfg. Co.
2810 East Pacific St., Philadelphia, Pa.
Reuben Haberman

Quebec Hydro-Electric Commission
107 Craig St., West, Montreal, Que.
Paul E. Poitras

Quebec Power Company
P. O. Box 1607, Quebec, Que. *Jean Saint-Jaques*

Rambusch Decorating Co.
40 W. 13th St., New York 19, N. Y.
Edward Rambusch

Revere Electric Mfg. Co.
6009-17 N. Broadway, Chicago 40, Ill.
Murray J. Whitfield

Revere Electric Supply Company
2501 W. Washington Blvd., Chicago 12, Ill.
Arthur Peterson

Rochester Gas & Electric Corp.
89 East Ave., Rochester 4, N. Y. *L. C. Twichell*

Rockland Light & Power Co.
Nyack, N. Y. *D. S. Schaab*

Rohm and Haas Co.
222 W. Washington Sq., Philadelphia 5, Pa.
W. T. Reedy

(Continued on page 32A)

LPI AREALUX

NOW . . . AT UNBEATABLE LOW COST . . . PERFECT LARGE AREA LIGHTING FOR LONG, NARROW STORES

As you know, at least 80% of the stores in your community are 3 to 4 times *longer* than their width. That's why efficient and attractive lighting of these narrow "corridors" is so difficult with the old-style louvered fixture. Note above how perfectly the LPI AREALUX answers this problem! What other fixture can match this combination of features: **1.** Large area light source, extra shallow. **2.** Louvers easily removable for cleaning. **3.** Exclusive hanger device for true alignment. **4.** Completely self-contained. **5.** Fixtures easily joined endwise or sidewise, or both, for large panels of light. **6.** Top efficiency alone or in combination. **7.** Surface, suspension, or recess mounted. **8.** Shipped fully assembled for installation at minimum cost. **9.** Fully wired with E. T. L. and U. L. approved ballasts. U. L. approved and I. B. E. W.—A. F. L. Union Label.

Best of all, cost-minded retailers will like the LOW PRICE. The LPI AREALUX is up to 20% lower in price than any and all fixtures that attempt to duplicate its exclusive combination of features. You will be serving users well when you recommend the LPI AREALUX.

LIGHTING PRODUCTS, INC., Highland Park, Ill.

Lighting Products, Inc., Dept. O, Highland Park, Ill.

Please send me LPI AREALUX Bulletin #470 — FREE and without obligation.

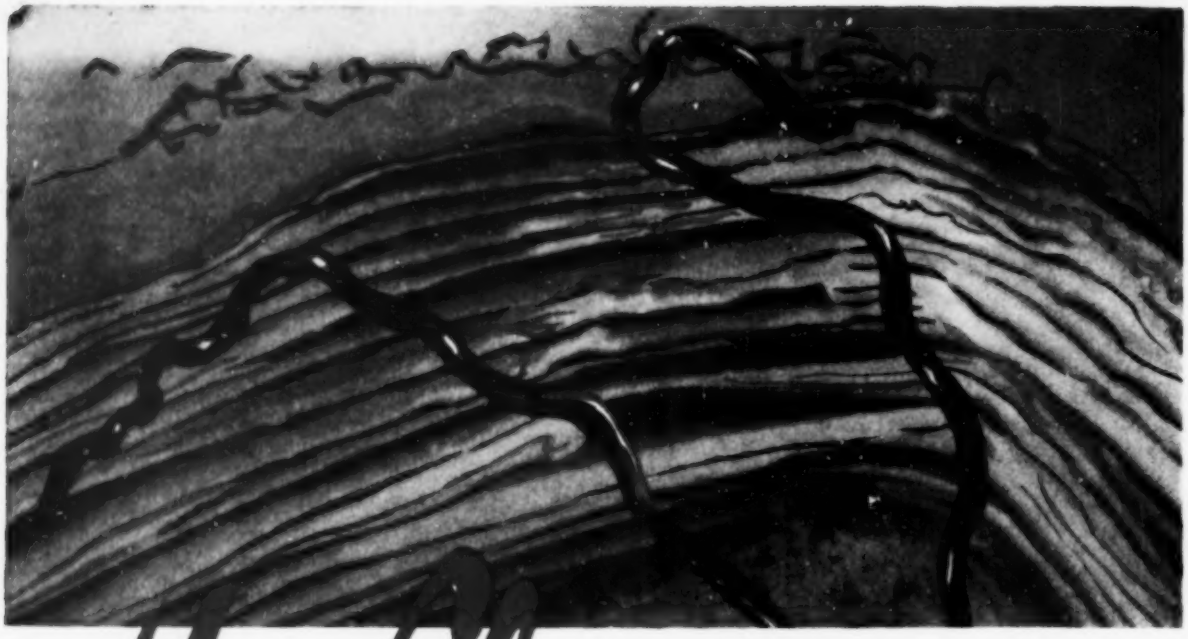
FIRM NAME_____

My Name_____

ADDRESS_____

CITY_____ **ZONE**_____ **STATE**_____

FREE Catalogue



How Close can you LOOK?

If *you* have to spend the time to look this closely at every item you buy, you'll soon either go blind or you won't have time to do anything but peer through a microscope. Besides, it's *our* job to see that every minute detail in the production of the ballast you buy is perfect to the closest tolerances for dependable performance. So, when we give you a closeup view of one of our coil windings, it's just to emphasize the fact that at Advance, we look *for* you before our ballasts go out of our factory.

The WORLD'S LARGEST MANUFACTURER DEVOTED *Exclusively* TO THE PRODUCTION OF FLUORESCENT BALLASTS

ADVANCE TRANSFORMER CO.

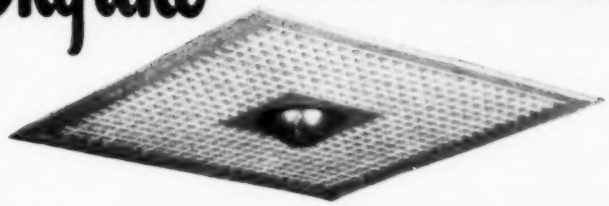
The Best Ballast Buy

CABLE ADDRESS: ADTRANS

1122 W. CATALPA AVE., CHICAGO 40, ILL., U.S.A.

Skylike

.....THE INCANDESCENT LIGHTING SYSTEM



SELECTED by one of America's finest department stores

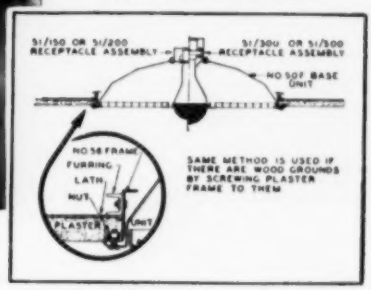
CARSON PIRIE SCOTT & CO.

for

APPEARANCE
EFFICIENCY
ECONOMY

Upper level of the new Carson Pirie Scott & Co. store at Evergreen Park, Illinois. Lighting fixtures are SKYLIKE using 500W silvered-bowl lamps

Cross section showing the simple installation method used for the SKYLIKE units



THE PROBLEM . . .

To provide a general lighting system, dignified in appearance, yet in perfect harmony with both the architectural and decorative scheme of the store. The system had to provide the color quality of filament lamps so important to general merchandising. Ceiling construction was hung wire lath, sprayed with U. S. Gypsum Sabinite. Lighting intensity required was 18 foot candles throughout the store.

THE SOLUTION . . .

Recessed SKYLIKE units using 500W. Silvered-Bowl Lamps were selected. They were centered in 10' x 18' areas and planned for in construction of the ceiling framing. Standard No. 56 plaster frames were installed when ceiling framing was built. Reflectors and louvers were installed after plastering was finished. The completed installation fulfilled all the basic requirements as to cost, quality and quantity of illumination.

Skylike . . .

The modern, versatile unit that can solve your lighting problems just as successfully as it has in countless installations in . . .

OFFICE BUILDINGS THEATRES BANKS
HOUSING DEVELOPMENTS SCHOOLS
RETAIL STORES LOBBIES SHOW ROOMS, ETC.

SKYLIKE
A SILVRAY-ASSOCIATED COMPANY

FOR COMPLETE DETAILS: A comprehensive 8-page booklet describing the SKYLIKE system and its simple installation is yours for the asking. To get your free copy, fill in and mail the coupon below.

SKYLIKE Lighting, Inc., 104 West Main St., Bound Brook, N. J.

Gentlemen:

Please send me complete information on Silvray **SKYLIKE**

NAME_____

FIRM_____ TITLE_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

(Continued from page 28A)

Ruby Lighting Corp.
1212 S. Olive St., Los Angeles 15, Calif.
Albert Jassim

Ruby-Philite Corp.
52-02 Queens Blvd., Long Island City 1, N. Y.
Louis Phillips

Rumsey Electric Co.
1007 Arch St., Philadelphia 7, Pa. *T. W. Lauer*

Ryall Electric Supply Co.
1160 Stout, Denver, Colo. *C. O. Ryall*

The Safety Car Heating & Lighting Co.
P.O. Box 904 New Haven 4, Conn. *J. J. Kennedy*

St. Joseph Ry., Light, Heat & Power Co.
520 Francis St., St. Joseph 2, Mo. *F. P. O'Connor*

Sandee Manufacturing Co.
5050 Foster Ave., Chicago, Ill. *R. L. Schramm*

Sandel Manufacturing Co.
3618 So. Loomis Place, Chicago 9, Ill. *A. L. Sandel*

San Diego Gas & Electric Co.
P.O. Box 1831, San Diego 12, Calif. *H. G. Dillin*

Savannah Electric & Power Co.
Savannah, Ga. *J. L. Davidson*

Schomer Electric Supply
104 S. Broadway, Aurora, Ill. *C. Petrik*

L. J. Segil Co.
2500 W. North Ave., Chicago, Ill.
Louis Rosenstein

Shalda Manufacturing Co., Inc.
835 S. San Fernando Blvd., Burbank, Calif.
William Shalda

Shawinigan Water and Power Co.
600 Dorchester St., W., Montreal, Que.
Chas. H. Talbot

The Sherwin-Williams Co.
101 Prospect Ave., N. W., Cleveland 1, Ohio
J. A. Meacham

Silvray Lighting, Inc.
R.K.O. Bldg., Radio City, New York 20, N. Y.
J. M. Gilbert

A. Edward Simpson
445 Richards St., Vancouver, B. C. *A. E. Simpson*

Smithcraft Lighting Division
A. L. Smith Iron Company
217 Everett Ave., Chelsea 50, Mass.
Hugh M. Nazor

Smoot-Holman Co.
321 No. Eucalyptus Ave., Inglewood, Calif.
L. A. Hobbs

Sola Electric Co.
4633 W. 16th St., Chicago 50, Ill. *L. C. Marschall*

Solar Light Mfg. Co.
1357 S. Jefferson St., Chicago 7, Ill. *A. Lazerson*

The Solex Co. Ltd.
280 Faillon St., West, Montreal, Que.
Leon Beauchamp

Southern Calif. Edison Co., Ltd.
601 West 5th St., Los Angeles 53, Calif.
Roy E. Dahlin

Southern Canada Power Co., Ltd.
355 St. James St., West, Montreal, Que.
George R. Atchison

Southern Colorado Power Co.
Box 75, Pueblo, Colo. *E. H. Pemberton*

Southern Indiana Gas & Electric Co.
P.O. Box 569, Evansville 5, Ind. *C. K. Graham*

Southern Lighting Mfg. Co.
501 Elwell St., Orlando, Fla. *Max K. Aulick*

Southwestern Electric Company
120 South Hewitt St., Los Angeles 12, Calif.
Edward C. Meyer

Southwestern Gas & Electric Co.
Box 1106, Shreveport, La. *J. E. Elliott*

Southwestern Public Service Co.
Dallas 1, Texas *J. E. Cunningham*

Stanley Electric Mfg. Co.
5700 S. 80th St., Philadelphia, Pa.
Bernard S. Heller

Steber Manufacturing Co.
2700 Roosevelt Rd., Broadview, Maywood, Ill.
Robert J. Besal

Steel Window Institute
Cheltenham, Pa. *George Hingston*

Steiner Electric Co.
3500 Milwaukee Ave., Chicago 41, Ill.
George S. Steiner

Sterling Reflector & Mfg. Co.
3249 West Grand Ave., Chicago 51, Ill.
Anton Oberhuber

Stonco Electric Products Co.
333 Monroe Ave., Kenilworth, N. J. *H. W. Spence*

Sunbeam Lighting Co.
777 E. 14th Place, Los Angeles 11, Calif.
Herbert L. Krieger

Sun-Lite Manufacturing Co.
2555 Bellevue Ave., Detroit 7, Mich. *Fred Binder*

Sun-Ray Fluorescent Co.
2025 South Michigan Ave, Chicago, Ill.
Jerome Gimbel

Super Electric Construction Co.
4300 W. Chicago Ave., Chicago 51, Ill.
P. M. Pavesich

Sylvania Electric Products, Inc.
1740 Broadway, New York 19, N. Y. *D. P. Caverly*

Tampa Electric Co.
Cass & Tampa Sts., Tampa 1, Fla. *F. J. Gannon*

Frank C. Teal Co.
3222-24 E. Jefferson, Detroit 7, Mich.
Harold C. Smith

Terreau-Racine Ltee.
196-228 St. Paul St., Quebec, Que. *Paul Ducasse*

Texas Electric Service Co.
Electric Bldg., Fort Worth 1, Texas
R. E. Hendricks

Thompson Electric Co.
1101 Power Ave., N. E., Cleveland 14, Ohio
Thayer B. Farrington

Toledo Edison Co.
Edison Bldg., Toledo 4, Ohio *Charles A. Harrison*

Toronto Hydro-Electric System
14 Carlton St., Toronto 2, Ont. *Wilson J. Wylie*

Triangle Electric Mfg. Company, Inc.
1112 Southwest First St., Miami, Fla. *Lee Minor*

Triangle Industries
600 W. Adams St., Chicago, Ill. *Leonard Cohen*

Tri-Part Mfg. Company
934 Plum St., Detroit 1, Mich. *Julius Reznik*

Tru-Lite Ltd.
824 Notre Dame St., W., Montreal, Que.
Omer M. Trudel

Underwriters' Laboratories, Inc.
207 E. Ohio St., Chicago 11, Ill. *Fred Neumer*

Union Electric Co. of Missouri
12th & Locust Sts., St. Louis 1, Mo. *W. L. Berry*

Union Metal Mfg. Co.
Canton 5, Ohio *W. A. Porterfield*

Unistrut Corp.
4118 Monroe Ave., Wayne, Mich.
James W. Attwood

Unistrut Products Company
1013 West Washington Blvd., Chicago 7, Ill.
George W. Butler

The United Illuminating Co.
80 Temple St., New Haven 6, Conn. *E. B. Haskell*

United Manufacturing Company
41 Haig St., Hamden 14, Conn. *Richard O. Gibbs*

United Wholesale Supply Corp.
10021 St. Broadway, Los Angeles 3, Calif.
Sam M. Neely

Utah Power & Light Co.
Box 899, Salt Lake City 10, Utah *W. A. Huckins*

John C. Virden Co.
6009-6109 Longfellow Ave., Cleveland 5, Ohio
W. G. Sawyer

John C. Virden, Ltd.
19 Curity Ave., Toronto, Ont. *P. G. Kirkpatrick*

Virginia Electric & Power Co.
Richmond, Va. *J. G. Holtzclaw*

Voigt Company
1636-38 N. Carlisle St., Philadelphia 21, Pa.
C. J. Frank

The F. W. Wakefield Brass Co.
Vermilion, Ohio *A. F. Wakefield*

Warren Electric Co.
P.O. Box 2594, Houston, Texas *J. R. Thompson*

Wasco Flashing Company
87 Fawcett St., Cambridge, Mass.
Selig M. Friedberg

The Washington Water Power Co.
P.O. Drawer 1445, Spokane 6, Wash.
Carl L. Hoffman

Webb Electric Mfg. Company
1701 S. W. Jefferson St., Portland 1, Ore.
F. E. Webb

Welsbach Engineering and Management Corp.
1500 Walnut St., Philadelphia 2, Pa. *H.H. Adams*

Westinghouse Electric Corp.
1216 W. 58th St., Cleveland 1, Ohio
(P.O. Box 5817) *Burt S. Burks*

Westinghouse Electric Supply Co.
113 North May St., Chicago 7, Ill. *B. H. Boatner*

Westinghouse Lamp Div.
Bloomfield, N. J. *Samuel G. Hibben*

West Penn Power Co.
14 Wood St., Pittsburgh 30, Pa. *Harry Restofski*

Wheeler Reflector Co.
275 Congress St., Boston 10, Mass. *K. A. Sawin*

White Way Electric Sign & Maintenance Co.
1317 Clybourn Ave., Chicago 10, Ill.
Martin Davis

Wiedenback-Brown Co., Inc.
111 Eighth Ave., New York 11, N. Y.
W. C. Stockberger

R. & W. Wiley, Inc.
119 Dearborn St., Buffalo 7, N. Y.
Robert C. Graves

H. E. Williams Products Co.
108 S. Main St., Carthage, Mo. *F. B. Williams, Jr.*

Wilmot Castle Co.
1255 University Ave., Rochester 7, N. Y.
E. H. Greppin

I. A. Wilson Lighting & Display Ltd.
280 Lakeshore Rd., Toronto, Ont. *J. A. Wilson*

The Windsor Utilities Comm., Hydro Div.
149 Chatham St., W., Windsor, Ont. *W. A. Shaw*

The Wiremold Company
Hartford 10, Conn. *D. Hayes Murphy*

Wisconsin Electric Power Co.
Public Service Bldg., Milwaukee 1, Wis.
G. W. Van Derzee

Wisconsin Power & Light Co.
122 W. Washington Ave., Madison 1, Wis.
J. D. Howard

Wisconsin Public Service Corp.
Green Bay, Wis. *A. G. Bur*

Worcester County Electric Co.
11 Foster St., Worcester, Mass. *Donald S. Bennett*

"...I'd say we made a sound investment in our Day-Brite lighting"

says Arthur Meier, Manager, Boyd's Men's Store, Clayton, Missouri.

MR. MEIER REPORTS: "Using sales as a barometer, I'd say we made a sound investment in our Day-Brite lighting. Especially at night, we're attracting a lot of store traffic. We can and *are* selling men's apparel at night with full assurance that color will not change in daylight conditions."

Boyd's in Clayton chooses Day-Brite's Mobilex® and Derby Downlights to light new store

The problem: lighting for a men's clothing store in a smart suburban shopping area where competition is keen. Objectives of lighting: (1) to make location dominant, (2) to get distinctive appearance at reasonable cost, (3) to provide properly balanced illumination for accurate nighttime appraisal of merchandise.

The solution: rectangular patterns of fluorescent Day-Brite MOBILEX with plastic panels and incandescent louvered Day-Brite Derby Downlights at each corner of MOBILEX patterns.

The recessed lighting units leave the ceiling smooth and unbroken. Visibility is excellent in every corner of the store. Light meter readings show 140 footcandles of illumination—yet the installation is extremely comfortable. There are no harsh shadows or glare.

The warm "punch" light of the Derbies give the installation sparkle and brilliance, and, teamed with MOBILEX, produce color balanced lighting for accurate appraisal.

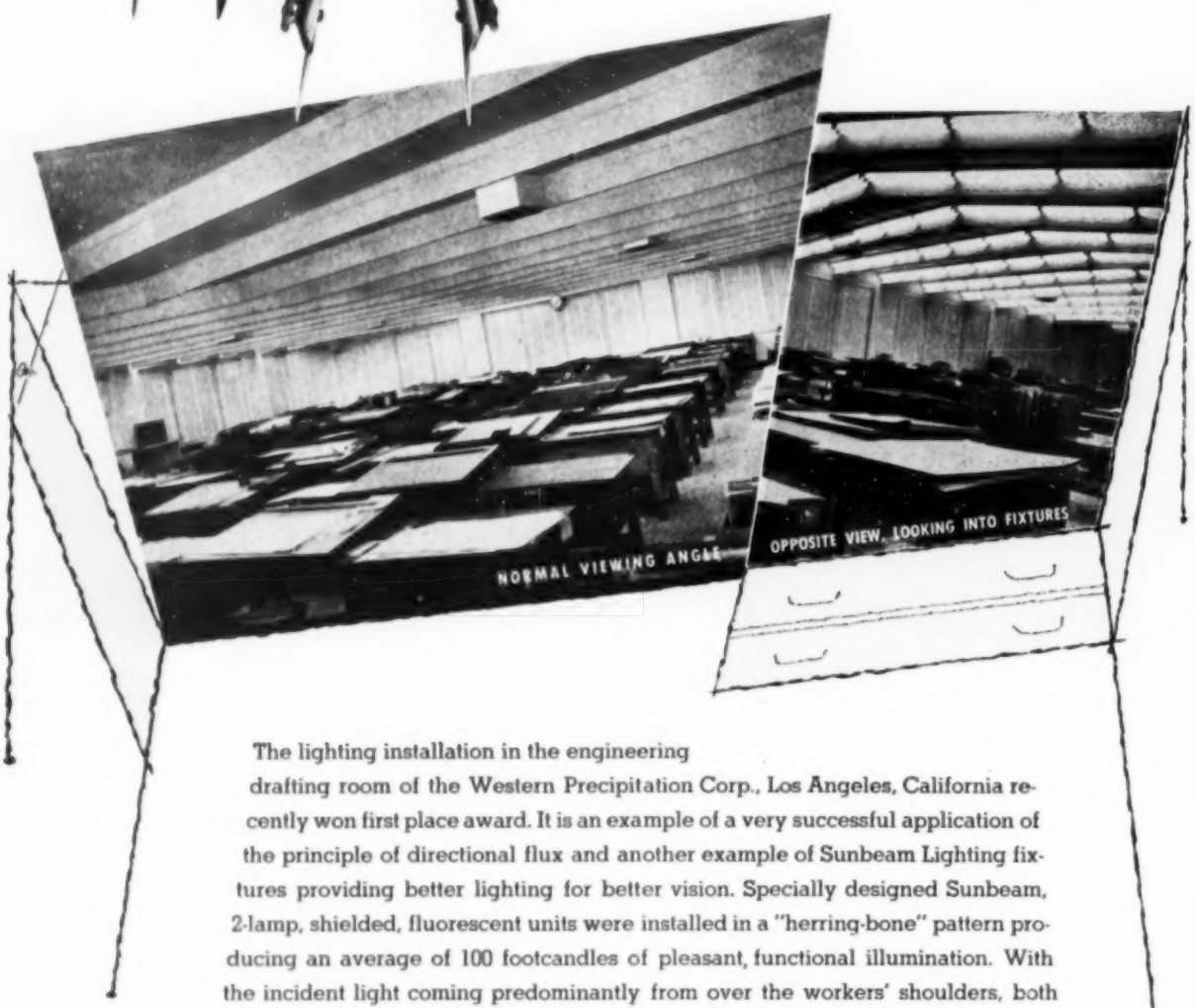
385

MOBILEX and Derby Downlights are only one of many answers Day-Brite has to meet your needs for store lighting fixtures that stimulate sales and improve business for your customers. We invite you to write for more information. Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis 7, Mo. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

DECIDEDLY BETTER
DAY-BRITE
Lighting Fixtures

ALL DRAFTSMEN AGREE

that better lighting
for better seeing
means better work.



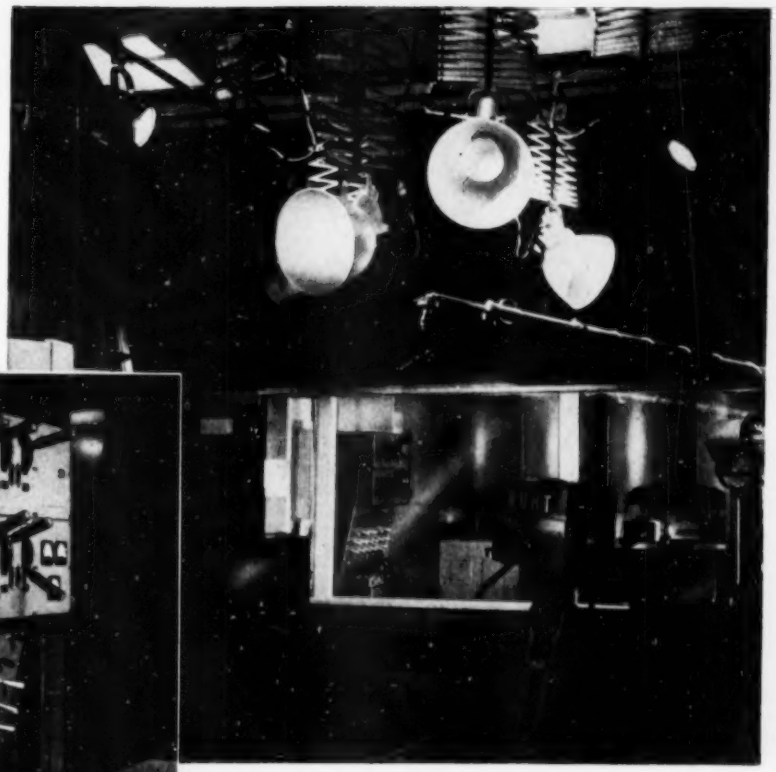
The lighting installation in the engineering drafting room of the Western Precipitation Corp., Los Angeles, California recently won first place award. It is an example of a very successful application of the principle of directional flux and another example of Sunbeam Lighting fixtures providing better lighting for better vision. Specially designed Sunbeam, 2-lamp, shielded, fluorescent units were installed in a "herring-bone" pattern producing an average of 100 footcandles of pleasant, functional illumination. With the incident light coming predominantly from over the workers' shoulders, both direct and reflected glare was all but eliminated and shadows around triangles and "T" squares greatly minimized.

SUNBEAM visionaire

SUNBEAM LIGHTING COMPANY • 777 EAST 14TH PLACE • LOS ANGELES 21, CALIFORNIA

Note dimmer board in the control room. Station KUHT-TV is managed by Mr. John C. Schwarzwalder. It is a venture of the University of Houston and the Houston Independent School District. The University has an enrollment of over 10,000 students. Its president is Dr. W. W. Kemmerer.

The Packaged POWERSTAT Dimmer board installation at KUHT-TV, built by the William E. Powell Mfg. Co. of Houston, Texas, consists basically of two Packaged types DCS6-2000 units mounted above a bank of single pole double throw switches.



big-budget TV studio lighting

obtained with low cost powerstat dimmers

Money was an object at KUHT-TV when it came to planning the studio lighting circuits — so was top performance. Consequently Mr. George L. Collins, art director, selected Packaged POWERSTAT light dimming equipment when he designed the board. By so doing he obtained the finest light control equipment at the lowest cost consistent with such quality.

The final arrangement provides almost unlimited flexibility and, when production permits, one bank of dimmers can even be used as a pre-set board.

Each Packaged POWERSTAT Dimmer is a complete switchboard in itself. It can also be used in combinations for greater capacity. KUHT-TV uses two of these packaged units, mounted one on top of the other, to control a multitude of lighting load circuits that is much in excess of the available dimmer circuits.

The standard line of Packaged POWERSTAT Dimmers can be adapted to meet complex light dimming requirements. Lighting engineers of The Superior Electric Company welcome the opportunity to help you plan an installation that is simple to install and to operate — with your budget fully in mind.

VOLTBOX A-C POWER SUPPLIES
POWERSTAT VARIABLE TRANSFORMERS
VARICELL D-C POWER SUPPLIES

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

POWERSTAT LIGHT DIMMING EQUIPMENT
STABILINE AUTOMATIC VOLTAGE REGULATORS
S-WAY BINDING POSTS

THE SUPERIOR ELECTRIC CO. 5093 Demers Avenue, Bristol, Connecticut

Please send free literature on POWERSTAT Light Dimming Equipment.

NAME _____
POSITION _____
CO. NAME _____
CO. ADDRESS _____
CITY _____ ZONE ___ STATE _____

THIS LABEL IS YOUR GUARANTEE OF THE FINEST

Eastern ENGINEERED

NOW!

90% EFFICIENCY

with Eastern's NEW "N" SERIES

FOR SCHOOLS, OFFICES and PUBLIC BUILDINGS

- 90% EFFICIENCY
- ONE MAN LOUVER INSTALLATION
- EXCLUSIVE "VIBRA-LOK" END SECTION
- SIMPLE LOW COST MAINTENANCE
- AVAILABLE IN 3 CUTOFFS
  35°— 25°, 35°— 45°, 45°— 45°
- FLUORESCENT OR SLIMLINE, 4, 6 & 8 FOOT UNITS

AND

"ZONE OF LIGHT" ILLUMINATION

WITH EASTERN'S NEW "4 Lamp N SERIES"

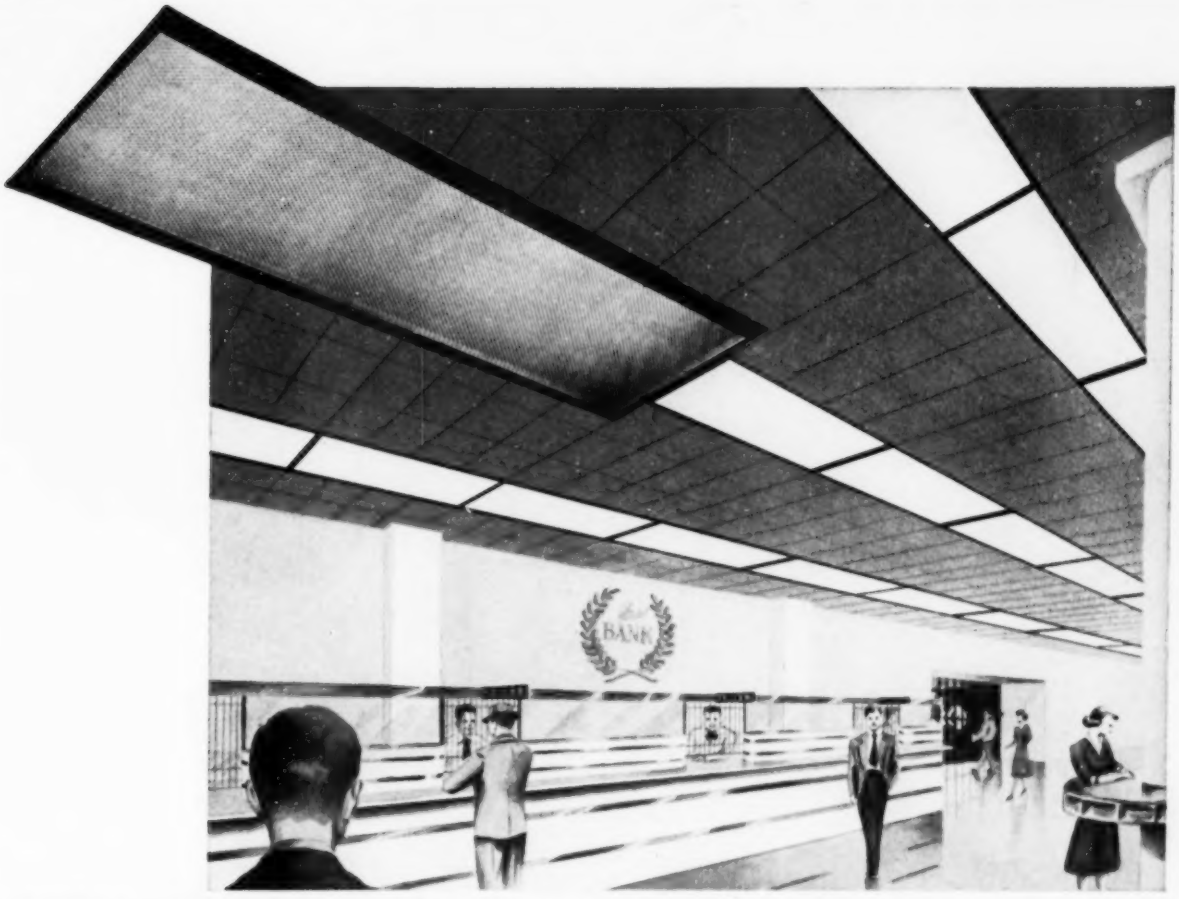
- LOW BRIGHTNESS — HIGH EFFICIENCY
- EXCLUSIVE "VIBRA-LOK" END SECTION
- PRE-TENSIONED, TEMPERED STEEL SPRING & LOCKING CLIP HOLD PLASTIC OR METAL SIDES IN POSITION
- TWO SECTION LOUVER FOR EASE OF HANDLING & MAINTENANCE — PERMITS RELAMPING OF 2 UNITS FROM ONE LADDER POSITION
- FLUORESCENT & SLIMLINE, 4, 6 and 8 FOOT UNITS

Eastern ENGINEERED

WRITE FOR YOUR COPY OF EASTERN'S NEW CATALOG SHEET WITH COMPLETE DETAILS ABOUT THE "N" SERIES

EASTERN FIXTURE COMPANY

170 VERNON STREET, BOSTON 20, MASS.



NEW LIGHTING GLASSWARE

gives you low surface brightness...yet delivers maximum light

Can be cut to your specific dimensions:

Now you can provide schools, banks, general offices and public buildings with a truly low-brightness lightweight lens panel.

A new conception in lighting glassware, Corning's Pattern No. 70 low-brightness lens panel reduces brightness by prismatic action in the glare zones. It provides you with brightness and distribution control in all directions through the uniform configuration of six-sided pyramids.

Equally important, new Pattern No. 70 lens panels deliver the maximum amount of light in the useful zones.

Made from engineered glassware, these panels cannot warp, fade or discolor. They add decor to any installation . . . lighted or unlighted.

Color quality is of the most modern standards, and exceptional light weight assures you easy installation. Smooth surface of glass permits rapid, cost-cutting cleaning and maintenance.

Available in lengths up to 100" and widths to 24", Pattern No. 70 lens panel can be cut to your dimensions, giving you freedom of expression in designing applications. They are particularly adaptable in luminous elements, troffers and fixtures where low surface brightness is required. For full information, send for Corning's new Lighting Sales Bulletin. Simply clip and mail the coupon.

CORNING GLASS WORKS

Corning, N. Y.

PYREX

Corning means research in Glass

CORNING GLASS WORKS, Dept. IE-9, Corning, N. Y.
Please send me a copy of your new Lighting Sales Bulletin.

Name ..... Title .....

Firm .....

Address .....

City ..... Zone ..... State .....

G-E Rapid Start Ballast Now Certified by CBM!

CBM CERTIFIED by ETL

Now, for the first time, you can offer your customers CBM certification in Rapid Start fluorescent lighting. This General Electric ballast, for the operation of two 40-watt Rapid Start lamps, meets the exacting specifications which Certified Ballast Manufacturers have recently designated for Rapid Start operation. Electrical Testing Laboratories subjected this G-E ballast to a series of thorough tests which verified the quality, safety and full-rated performance of General Electric's Rapid Start design.

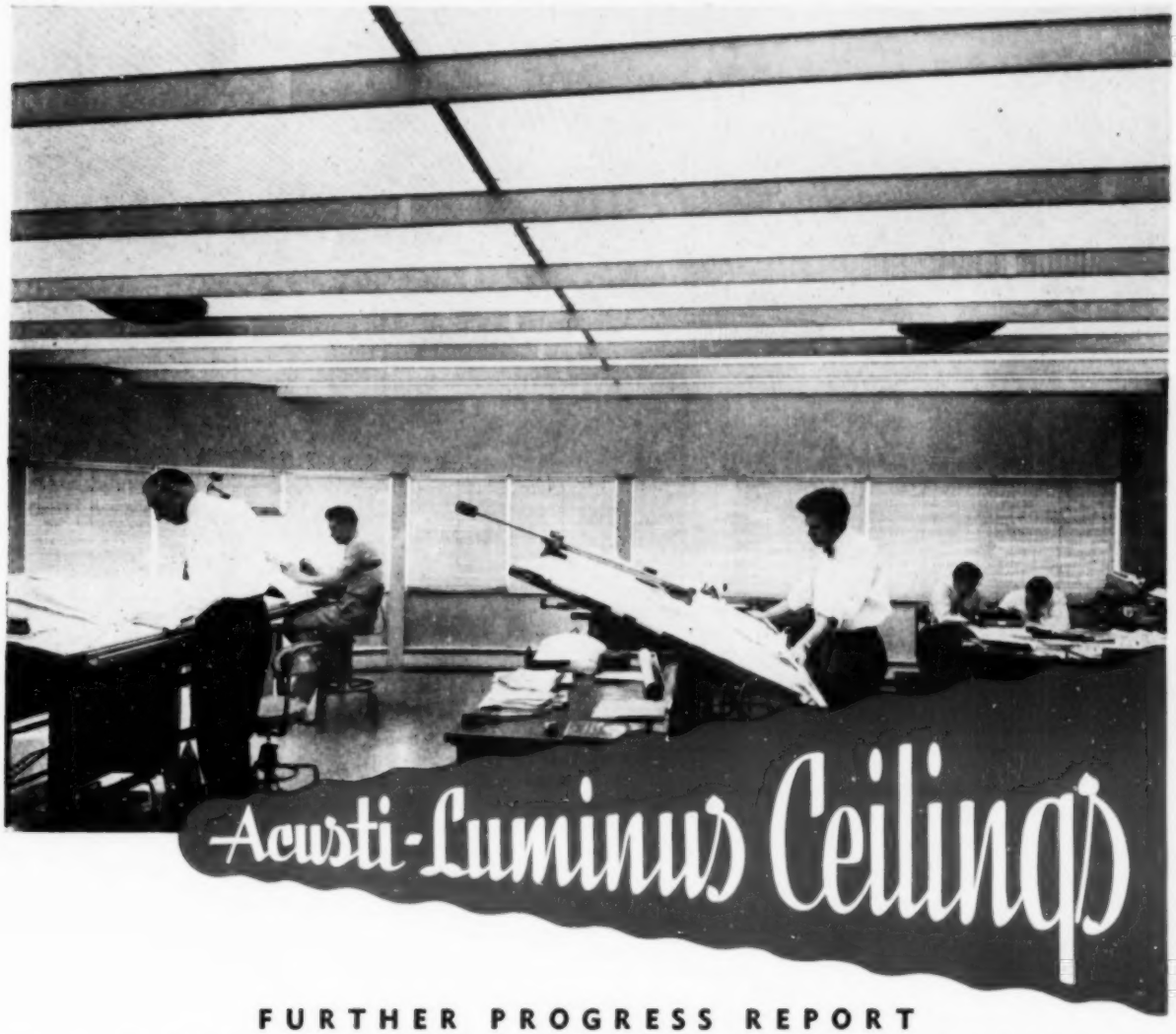
First to introduce fluorescent lighting, in 1938, General Electric again led the way in 1952 . . . in the development, introduction, and first application of Rapid Start lamps and ballasts. Now, CBM certification of this G-E Rapid Start ballast is further evidence of the progress you expect from General Electric—a leader in fluorescent lighting.

For complete information on General Electric's full line of ballasts for fluorescent lamps, contact your nearest G-E Apparatus Sales Office or authorized G-E Distributor. General Electric Company, Schenectady 5, N. Y. 412-108

You can put your confidence in—

GENERAL ELECTRIC

Low Cost PERFECT ILLUMINATION



FURTHER PROGRESS REPORT

Now more than 2000 ACUSTI-LUMINUS CEILINGS in 35 states. Installed under varying conditions and doing a commendable lighting and sound conditioning job. All this at prices that make ceiling advantages available to most users.

While most installations have been in offices, there are innumerable drafting rooms, schools, ticket offices, laboratories, auditoriums, stores, lobbies, control rooms, and many industrial areas. All Underwriters' Labeled, for use even under sprinklers.

Enthusiastic users, including many Utility Companies, Architects and Engineers, are specifying additional ACUSTI-LUMINUS CEILINGS. We are Ceiling specialists. Do not hesitate to consult us. Write for information and quotations for specific areas.

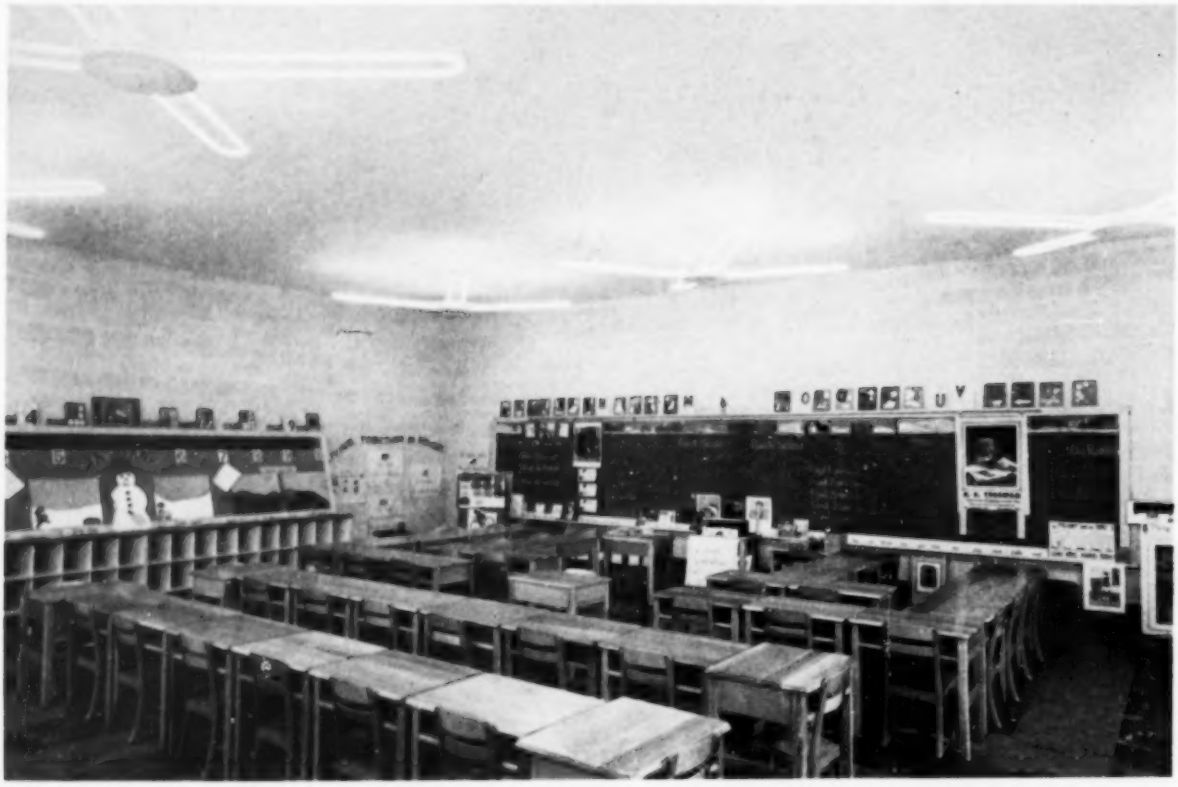
NATIONAL TECHNICAL CONFERENCE
See us at the Commodore Hotel, September 14-17. We will be happy to show you ceiling installations.

LUMINOUS CEILINGS INC.

2500 W. NORTH AVE., CHICAGO 47, ILL.

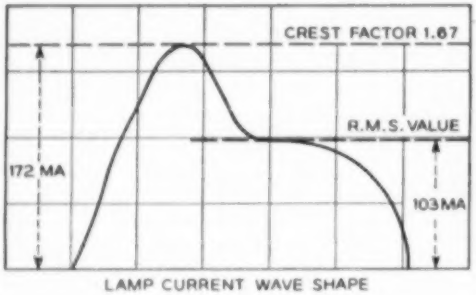
• • DISTRICT OFFICES • •
NEW YORK • BOSTON • PHILADELPHIA • WASHINGTON, D.C.
DETROIT • CLEVELAND • LOS ANGELES • SAN FRANCISCO

Why Cold Cathode "Hairpinline" Lighting—



FACTS about the new 4-lamp Cold Cathode Ballast developed by R. C. Hultgren & B. C. Pretzer used in all I.E.C. HAIRPINLINE fixtures ONLY.

Total watts	187
Amperes	1.67
Secondary MA	103
Lamp Watts	39.4
Lumens per lamp	2220
Lumens per watt	48
Longer lamp life	
Peak current to R.M.S.	1.67 to 1
Operates 6MM. pressure lamps	
No flickering of lamps	



LAMP CURRENT WAVE SHAPE

Results have shown that due to higher maintained footcandles, less reflected glare, 400% less lamp burnouts, and the absence of expensive louvers, the **LOW BRIGHTNESS HAIRPINLINE** cold cathode fixtures are setting new **STANDARDS** and **NEW DEMANDS** in classroom lighting all over the country—**HERE'S WHY**—

DATA FROM OVER 500 INSTALLATIONS WHEN NEW AND AFTER *THREE YEARS* OF OPERATION *WITHOUT CLEANING.*

Initial FC on desk	41
Initial FC on walls	29
FC on desk after 3 years	29
FC on wall after 3 years	22
Depreciation after 3 years	29%
Fixtures per room	6
Room Size	22'x30'x12'
Watts per room	1122
Coefficient of Utilization	51
Maintenance factor (no cleaning)	69
Footlamberts 0°-45°	985
Footlamberts 45°-60°	870
Footlamberts 60°-90°	840

COLD CATHODE LAMPS WHEN OPERATED BY THE NEW 4-LAMP BALLAST ARE GUARANTEED AGAINST BURNOUTS FOR *THREE YEARS.*

ILLUMINATING ENGINEERING COMPANY

—— Originators & Pioneers of Hairpinline Fixtures ——

Hazel Park, Michigan

NO MORE GUESSWORK IN BRIGHTNESS READINGS

New *SPECTRA* instrument actually *eliminates human factors.*
Gives brightness readings automatically; instantaneously

NEW *SPECTRA* BRIGHTNESS SPOT METER

Now Illuminating Engineers and others whose work requires fast, accurate lighting calculations can have a new, highly dependable instrument absolutely free from human estimate . . . light, compact and easily portable . . . adaptable for all types of work indoors and outdoors.

Developed from Photo Research's long experience in design, manufacture and use of exposure meters, densitometers, color temperature meters, filters and other precision photographic instruments, the SPECTRA BRIGHTNESS SPOT METER is the first such commercial illumination measuring instrument. By automatically measuring the brightness of a small spot from a remote location to the I.C.I. Standard luminosity curve, this meter saves valuable time and provides direct reading instant accuracy.

SPECIAL FEATURES OF *SPECTRA* BRIGHTNESS SPOT METER

- Direct Reading in Footlamberts
- Small Angle
- Extreme Range of Sensitivity . . . from 0.1 to 1000000 ftls in six ranges
- Locking Microammeter . . . reading retained until button depressed
- Self-Contained . . . requires no external power or wiring. External, optional
- Completely Portable . . . small size and light weight
- Accuracy . . . better than 5% over entire sensitivity range
- Dependability . . . battery replacement only maintenance
- Focusing . . . from 4' to ∞ by rotating lens barrel . . . supplementary lens available to focus 1/10" at 2"

Write for illustrated brochure giving complete details of these special features, specifications of SPECTRA BRIGHTNESS SPOT METER, and various attachments for special purposes.

PHOTO RESEARCH CORPORATION
127 W. ALAMEDA AVE., BURBANK, CALIF.

NEW EQUIPMENT DATA
AVAILABLE WITH COUPON

New manufacturers' catalogs and bulletins listed below are available free to readers of ILLUMINATING ENGINEERING by mailing the coupon. Circle the numbers of those items which you want, drop in envelope or fasten securely to back of 2-cent postcard addressed to Publications Office.

1 Catalog page describes new "Stem-Winder" adjustable swivel stem fixture hanger said to allow 1½" vertical adjustment, keep fixtures plumb even when hung from ceilings pitched 25%. The Miller Co., Meriden, Conn.

2 Wallbox Dimmer folder shows applications and installation details of adjustable transformer for use in homes, hotels, churches, auditoriums, schools, and many other locations. Bulletin D10-52WBT. Superior Electric Co., Bristol, Conn.

3 Catalog pages cover new 500-watt floodlight, RLEE-14, said to be first ever developed with over 200-watt capacity for use in hazardous locations. Pages give description and construction details, as well as photometric data. Crouse-Hinds Co., Syracuse, N. Y.

4 New 8-page folder on Acusti-luminus ceilings shows numerous typical applications, construction details, light distribution, acoustical and airconditioning features. Luminous Ceilings Inc., Chicago, Ill.

5 72-page catalog in full color describes complete line of residential lighting fixtures manufactured and imported by company, from French gold and crystal candelabra through kitchen and outdoor fixtures. Halcolite Co. Inc., New York, N. Y.

6 Anti-static detergent for plastics is described in 4-page folder and some of its uses for plastic equipment and fabrics detailed. Also included are directions for use and prices. Merix Chemical Co., Chicago, Ill.

7 Peerlite, 8-page folder in color, shows company's new line of fluorescent fixtures under this brand name, available in 4- and 8-foot lengths for 2, 3 and 4 lamps and in a variety of mounting installations. Folder gives full photometric data and variations in louvers and other details. Edwin F. Guth Co., St. Louis, Mo.

8 20-page booklet describes Lite-Mite, high-intensity portables for localized lighting in a variety of industrial areas and in a variety of types, includes fluorescent and incandescent, screw-in, flex-arm, hand lites, and others. Stocker and Yale, Inc., Marblehead, Mass.

9 New Pioneer line of fluorescent fixtures is covered in 4-page folder, which suggests applications in schools, offices, and retail stores, and tells of exclusive adaptable socket holder bridge. Photometric, installation and construction data included. Smithcraft Lighting Division, Chelsea, Mass.

10 New 20-page brochure covers subject of engineered glass and methods employed to maintain high manufacturing standards to meet strict specifications; touches on optical transmission properties, beam control, engineering design; shows 200 specialty glass items made by company. Kopp Glass Inc., Swissvale, Pa.

11 Beta-Plex folder describes new series of modular lighting units for recessed mounting in suspended ceilings in multiples of 1' x 4', 2' x 4', and 4' x 4'. 8-page folder gives specifications and construction details, covers maintenance and installation features. F. W. Wakefield Brass Co., Vermilion, Ohio.

12 64-page measuring equipment catalog contains information on 115 testing and measuring devices for laboratory and production line use, ranging from simple current indicators to completely automatic oscillographs, from d-e amplifiers to radiation monitors. General Electric Co., Schenectady, N. Y.

13 Completely new 80-page catalog illustrates and describes complete line of company's lighting fixtures; gives dimensional data, lighting curves and other details on fluorescent and incandescent fixtures for commercial, industrial and outdoor use. Electro Silv-A-King Corp., Chicago, Ill.

14 Catalog sheet gives information on new cold cathode ballasts, type CK 2812-11, for use with two 93" cold cathode lamps, states no light loss by voltage variations or aging lamps, illustrated with performance charts. Acme Electric Corp., Cuba, N. Y.

15 Chalkboard lighting for schoolrooms is discussed in new treatise by L. V. James, lighting consultant, released by this company. Article gives reasons, types of installations and other data. Solar Light Mfg. Co., Chicago, Ill.

16 New catalog sheets give specifications, installation and photometric data, including distribution curves and coefficients of utilization on company's Plexoline-4 fluorescent fixtures and Duo-Frame recessed incandescent units. Day-Brite Lighting Inc., St. Louis, Mo.

17 10-page bulletin 1B-3239 features non-technical descriptions of lamp group replacement plans in a number of different types of industrial plants and retail stores and outlines the benefits of these plans, such as lower labor costs, higher lighting levels, greater efficiency, and lower accident rates. General Electric Co., Cleveland, Ohio.

18 New 1953 edition of RLM Standards Specifications Book, containing three new specifications for semi-direct industrial fluorescent lighting units and including new tables of coefficients of utilization and light distribution curves. RLM Standards Institute, Chicago, Ill.

19 New booklet, B-5644, describes Quicklag circuit-breaker panelboard for lighting and appliance branch circuit applications, and said to be less expensive and smaller than comparable conventional type panelboard. Westinghouse Electric Corp., Pittsburgh, Pa.

Offer good for two months

Circle numbers wanted. Enter name and address. Clip out and mail.

PUBLICATIONS OFFICE 9-53
ILLUMINATING ENGINEERING SOCIETY
1860 Broadway
New York 23, New York

Send me items circled below:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Name _____

Company _____

Street _____

City _____ Zone _____ State _____

WILSON

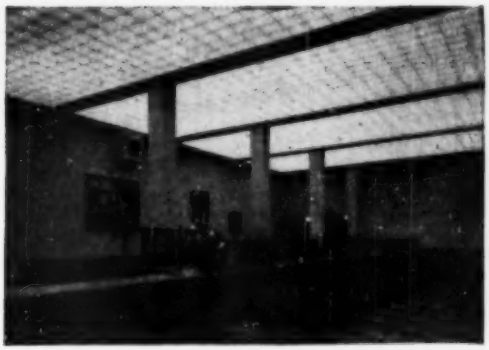
"LUVE-TILE"

IT'S THE SIMPLEST... MOST PRACTICAL... LIGHTING INSTALLATION YOU EVER HANDLED

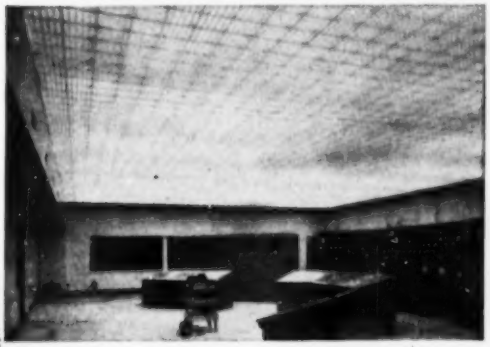
This latest development in modern interior lighting is a boon to contractors because . . .

- It is extremely simple to calculate the amount required for the installation.
- There are only four basic elements to use! A modular 12" square of rigidly molded polystyrene louvre, a clip, a hanger and a strap.
- There are no complicated T-bars necessary to support "Luve-Tile".
- "Luve-Tile" always aligns perfectly and pleases customers with its symmetry.
- "Luve-Tile" is scientifically designed and is correct from an efficiency and brightness viewpoint.
- When the installation is complete, it is very simple to maintain—an important factor in customer approval.

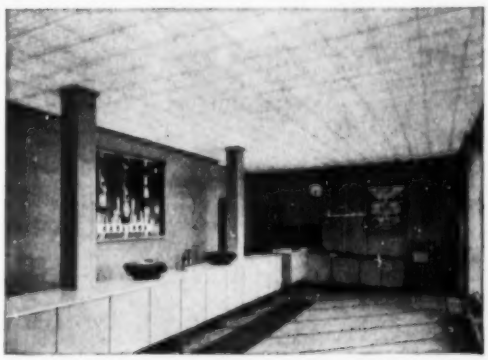
For complete information on "Luve-Tile" write for Catalog, Section #8.



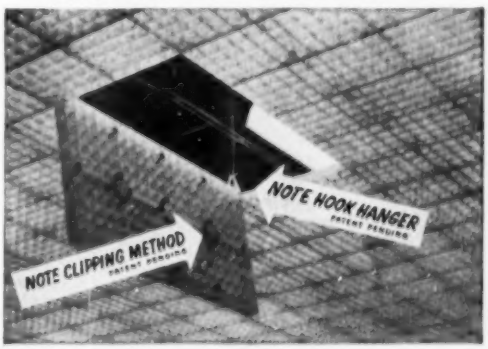
● Illustration shows a modern bank installation, where "Luve-tile" helped to achieve an air of efficiency.



● In this power control room, "Luve-tile" has successfully cut down glare and eyestrain.



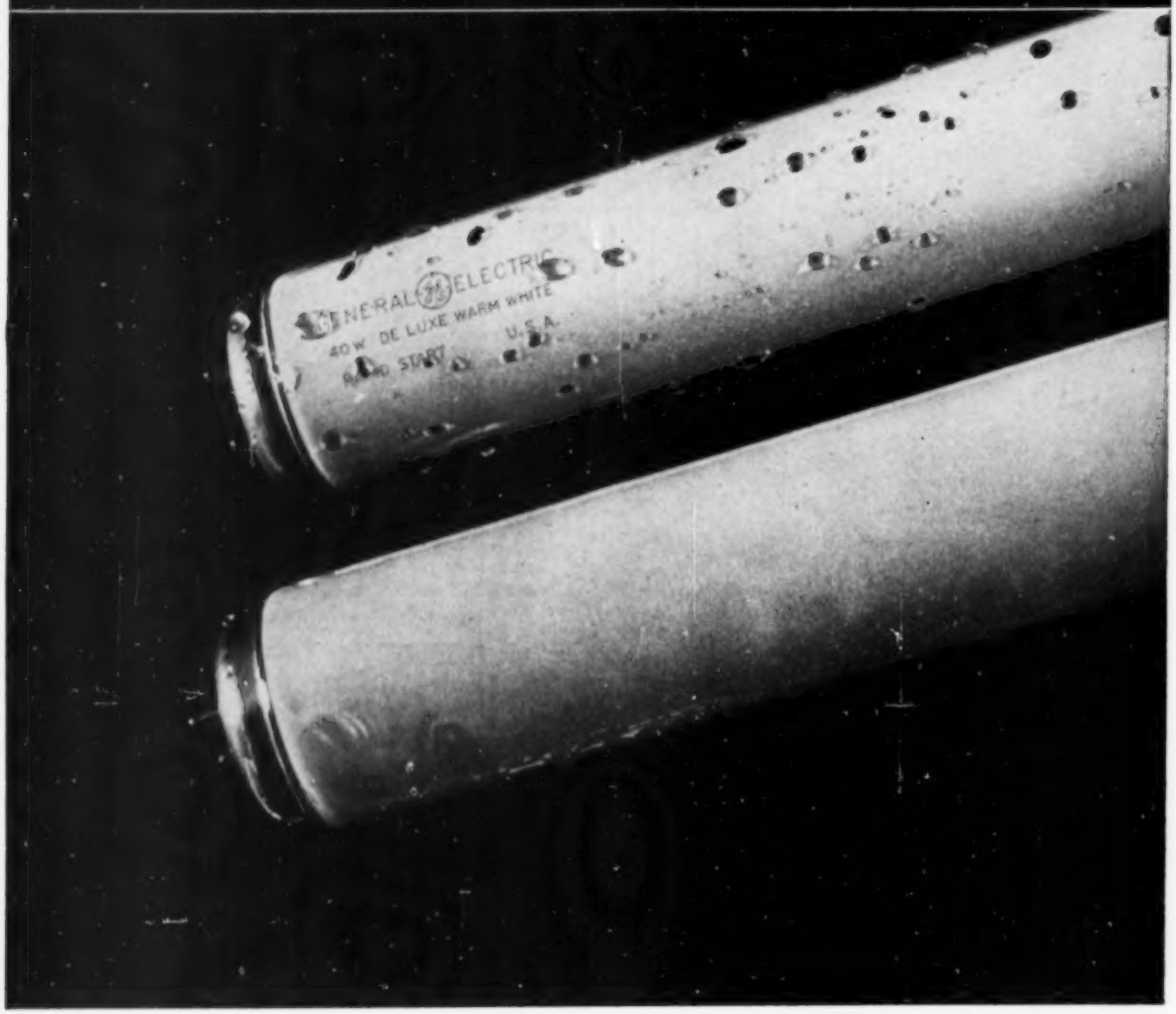
● "Luve-tile" was a major factor in achieving the modern appearance of this retail store.



J. A. WILSON LIGHTING & DISPLAY INC.
995 MAIN ST. — BUFFALO 3, N. Y. — Phone Grant 2135
In Canada: 280 Lakeshore Road, Toronto 14, Ontario

ANOTHER WILSON FIRST

You expect the best value from G-E fluorescent lamps



Silicone coat on new G-E Rapid Start lamps helps them start quicker

Moisture in the air can make a fluorescent lamp slow to start. The wet film that condenses on the lamp is a good enough conductor to detour some of the electricity needed for proper starting.

General Electric has tailored a "raincoat" that stops this. It's made of silicone and breaks up the wet film into tiny droplets, leaving dry areas that interrupt the electrical contact. Less current is stolen. Starting is quicker, surer.

We call the coating Dri-Film*. The photo above shows the difference it makes. Moisture breaks up into droplets on the Dri-Film* lamp, forms a smooth coating on the ordinary lamp.

You get Dri-Film* on G-E Rapid Start lamps. It's invisible, won't rub off, helps assure you all the light you pay for. Many leading manufacturers have designed lighting fixtures to use Rapid Start lamps and their special Rapid Start ballasts. You *expect* the best value from G-E fluorescent lamps. Here's another reason you can.

For more information, write General Electric, Department 166-IE-9, Nela Park, Cleveland 12, Ohio.

*Reg. U. S. Pat. Off.

You can put your confidence in—

GENERAL ELECTRIC

(Continued from page 21A)

Dr. Carsten C. Steffens, assistant director of Stanford Research Institute from 1947 to 1949, has returned to the Institute as technical coordinator of the research divisions. For the past four years Dr. Steffens has been associate professor of chemistry at the University of New Mexico. In his new position he will follow progress of all research groups and act as technical advisor on certain industrial projects.

Herbert L. Schreiner has been named special sales representative for national accounts of the Lighting Division of Sylvania Electric Products Inc. and will be located at the company's New York headquarters office.

Solar Light Manufacturing Co. has named **Frank X. Chassaing**, 3401 La-Branch, Houston, Texas, as sales representative for the state of Texas. Mr. Chassaing was formerly vice-president in charge of the lighting division for Southern Electric Supply Co.

Sunbeam Lighting Co., Los Angeles, announces the appointment of **Joseph L. Noveski** as National Sales Manager. Mr. Noveski was formerly District Supply Sales Manager for the Los Angeles district of the General Electric Supply Co.

Supreme Lighting Co., Los Angeles, announces the addition of **C. A. Bedell** to their sales engineering staff. Mr. Bedell will serve as factory representative in San Diego County, Nevada, Arizona, New Mexico and Western Texas with headquarters in San Diego.

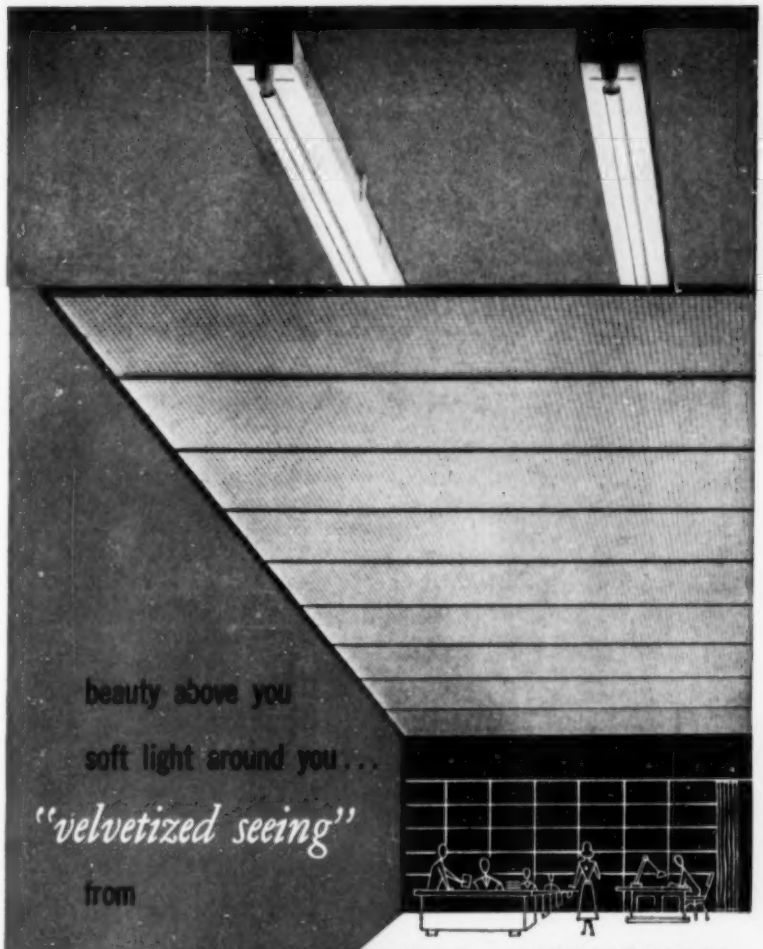
Unistrut Products Co., Chicago, announces the promotion of **George C. Foy** to the newly created post of Mid-Western Manager covering a territory of 16 states. Mr. Foy will have headquarters at 1013 West Washington Blvd., in Chicago.

Hoffman S. Beagle has been named Assistant to the President of Electrical Testing Laboratories, Inc., New York, N. Y. Mr. Beagle was formerly manager of the Heating Products Division of the Miller Company, Meriden, Conn.

Jack Hall has been appointed Director of Sales of Acme Electric Corp., Cuba, N. Y. Mr. Hall, who has been with the company since 1947, was formerly a field representative.

Bernard Braverman has been appointed manager of the Lamp Department of the Keps Electric Co., Pittsburgh, Pa. Mr. Braverman has been with the company for the last six years.

(Telecast continued on page 46A)



GUTH GRATELITE* CEILINGS

covered from wall to wall with GrateLite, the diffusing plastic louver . . . an architectural dream.

Diffusion through 3/8" translucent cubical facets produces finer quality illumination . . . fills the room with soft light for "VELVETIZED SEEING". It keeps your eyes "at rest" and makes your work easier.

simple installation: Just 5 parts to handle.

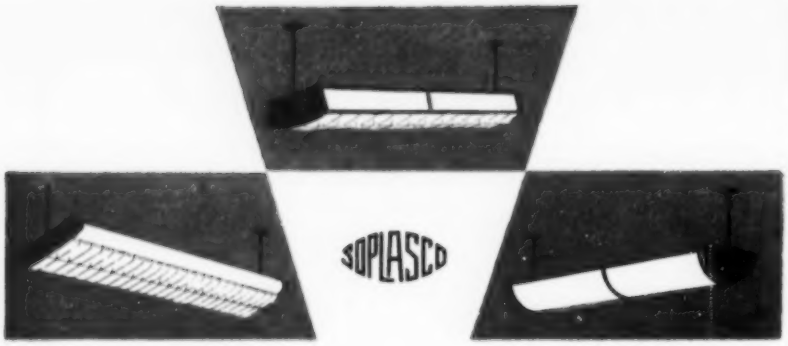
easy maintenance: Relamp by removing only 1 panel. Panels can be detached and washed in 2 minutes . . . just shake in detergent water.

Start a new era of eye comfort—with up to 200 foot-candles! Write today on your letterhead for folder 905-1 and GrateLite layout guide.

Guth

THE EDWIN F. GUTH CO. ST. LOUIS 3, MO.

*U. S. & Can. Pats. Pend.
Trademark Registered



PLASTIC PANELS

Southern Plastics Company stands ready at all times to work with your designers and engineers.

Southern Plastics is equipped to develop an extrusion or mold to your specifications or to design the extrusion or mold to fit your needs, as they have done for the largest lighting fixture manufacturers in the world.

SOUTHERN PLASTICS Co.

408 Pendleton St. Columbia, S. C.

MORE AND MORE FOR LESS AND LESS

Our constant program of research has developed more and more ways to improve the performance of ballasts, adding quality often at no extra price, in face of tremendous material cost increases.

ACME ELECTRIC CORP., LTD. • 50 N. Line Rd., Toronto, Ont., Canada
ACME ELECTRIC CORP. 299 Water St., Cuba, N. Y.

Acme ACME Electric
TRANSFORMERS

BOOKS AND PAMPHLETS

*Books whose reviews are marked * are available for inspection at the I.E.S. Headquarters Office, Technical Dept.*

***Photometry** — by John W. T. Walsh, published by Constable & Co. Ltd., London, 1953; available in the United States from the Macmillan Co., New York; 544 5¾ x 9¼ inch pages, 281 illustrations. Price $12.75.

This is the second edition of the volume written by Dr. Walsh in 1926. It is one of the most comprehensive books on photometry now available. Topics treated in detail include:

History of photometry; radiation physics; the eye and vision; photoelectric cells; basic photometric principles; standards and sub-standards; measurement of luminous intensity; light distribution and total flux measurement; heterochromatic photometry; colorimetry; spectrophotometry; illumination and brightness; measurement of reflection, transmission and adsorption factors; photometry of projection apparatus; stellar photometry; and finally, the photometric laboratory. The appendices include 22 pages of valuable reference data.

Until his recent retirement, the author was with the Light Division of the National Physical Laboratory in England; he is a past-president of the British Illuminating Engineering Society, and currently vice-president of the International Commission on Illumination.

***Modern Electric Lamps** — by D. A. Clarke, published by Blackie and Son, Limited, London, 1952; 214 5¾-inch pages, 147 illustrations; price 20s (approx. $2.80).

This British book was written as a general text for electrical engineering students. Chapter headings and coverage are indicated below:

1. The Nature of Light — the physics of light.

2. The Metal-filament Lamp — temperature characteristics, efficiency, construction, manufacture, electrical characteristics.

3. Electric Discharges in Gases and Vapours — fundamentals in terms of atomic and molecular structure.

4. The Sodium-vapour Lamp — construction, electron emission, thermionic emission, field emission, electrodes, starting and operating conditions, control equipment.

5. Neon Lamps — visual characteristics of the discharge, electron physics, neon spectrum, neon glow lamp, positive

(Continued on page 48A)

EMPLOYMENT OPPORTUNITIES

SALES REPRESENTATIVES WANTED

The Modern Light Company of St. Louis is expanding its field sales force, and agency sales contracts are available for the following territories: Nebraska, South Dakota, North Dakota, Minnesota, Wisconsin, Kentucky, Tennessee, Ohio, Michigan, Southern Illinois, and Northern Illinois. Representatives interested in an agency or commission basis are invited to communicate with the Modern Light Company of St. Louis, 7809 Maplewood Industrial Court, St. Louis 17, Mo.

LIGHTING ENGINEER

Available immediately, over 18 years' experience; specialist in airport lighting development and application; also, street commercial and lighting sales. Age 48, married. BSEE degree. Will consider offer from large or small concern in engineering or sales. Best references. Well qualified. Address Box 195, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

SALES AND APPLICATION ENGINEER

B.S. in E.E., age 26. Presently represent manufacturers of architectural commercial lighting equipment. Confronted by need to join a larger organization with expanding horizons and opportunities for personal growth. Experienced in fixture design, application layout and sales through architects, engineers, contractors, distributors, institutions, and retail chains and department stores. Associate Member, I.E.S. Address Box 194, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

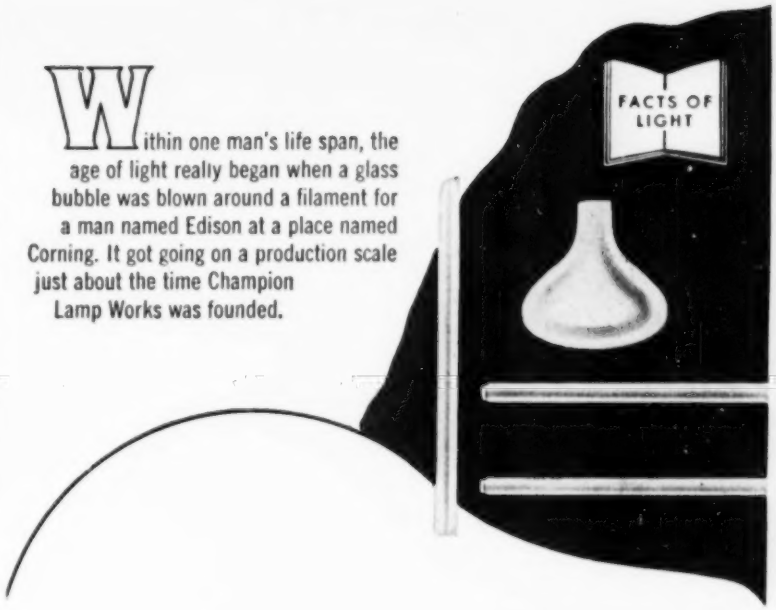
IT'S
ALL-WHITE
ABOLITE

• Cooler, cleaner lighting plus longer lamp life. That's what you can expect with the new ABOLITE "All-White" lifetime, porcelain enameled fixtures. The ventilating slots provide automatic air circulation, prevent dust from fogging lamp and reflector.

Ask your wholesaler for complete details.

ABOLITE Lighting DIVISION
THE JONES METAL PRODUCTS CO.
WEST LAFAYETTE, OHIO

Within one man's life span, the age of light really began when a glass bubble was blown around a filament for a man named Edison at a place named Corning. It got going on a production scale just about the time Champion Lamp Works was founded.



CHAMPION The glass of a *Champion*

Now, today's "ribbon" machine turns out a million incandescent bulbs a day to glass wall thickness tolerances of no more than .0075". Fluorescent tubes are blown and drawn to outside diameters not more than .038" from standard.

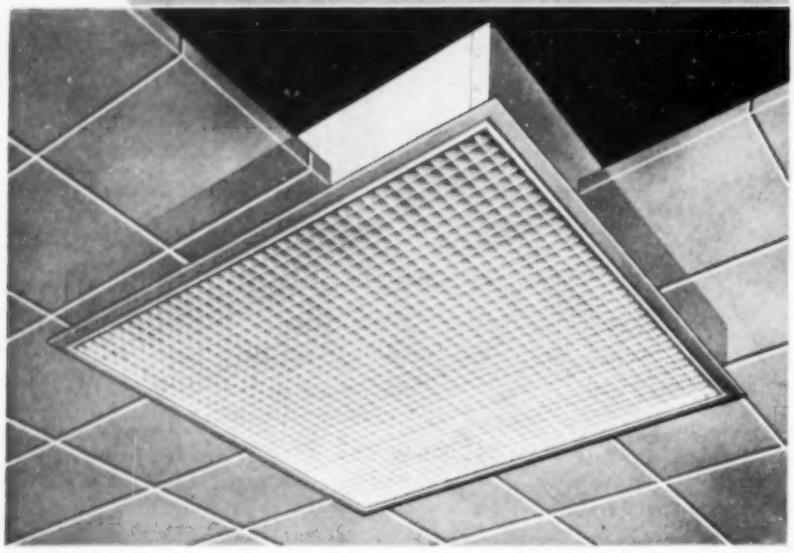
Glass for Champion Lamps is truly a marvel of modern chemistry and production control. It must be strong and resistant to the attack of water, chemicals, fumes, grit, wind and flame. It must keep Champion Lamps ready to light up at the flick of a switch — ready to perform like Champions.

May we mail you a copy of the new booklet L entitled ***CHAMPION QUALITY?*** *It contains many interesting facts and illustrations.*

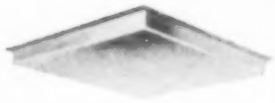
CHAMPION LAMP WORKS
Lynn, Massachusetts
A DIVISION OF CONSOLIDATED ELECTRIC LAMP CO.

EFFICIENT
FUNCTIONAL
CONTEMPORARY

THE *LEADLIGHT* SQUARE SERIES



To economically illuminate large areas having varying lighting demands within the whole—use handsome LEADLIGHT SQUARE FIXTURES and *reduce the number of units required! Possible* because *each unit* provides concentrated light for specific sections of the area, plus abundant light for overall general illumination.



LEADLIGHT SQUARE FIXTURE
with smooth surface
Plexiglas® diffuser

VERSATILE Applications—Capacities—Design!

- *Low in first cost, installation and maintenance.*
- *Splendid for department store, office, cafeteria, drafting room, library, bank or auditorium use.*
- *Available in surface mounted, recessed or suspended types.*
- *Injection molded plastic louvers with 45° x 45° shielding angle.*
- *Also available with diffusing Plexiglas® bowl bottoms, corrugated plastic bottoms.*
- *Hinged louver frame with snap hooks for easy lamp replacement and maintenance from one point.*

4'x4' for 4, 6, 8 or 10 lamps . . . either conventional 40 watt or T-12 single pin Slimline

3'x3' for use with 30 watt lamps

2'x2' for use with 20 watt lamps

6'x6' for use with 72" Slimline lamps

Slimline models feature 430 milliampere instant-start operation; 40, 30 and 20 watt units have easily replaceable starters

All units phosphatized, insuring a rust proof installation

For MORE Light . . . BETTER Light . . . ALWAYS look to *LEADLIGHT!*

Write for New Catalog —Today!

LEADLIGHT FIXTURE COMPANY
DIVISION OF OAKLAND ENGINEERING CO., INC.
800-100th AVENUE • OAKLAND 3, CALIFORNIA

Please send me the new LEADLIGHT Catalog:

Name _____

Firm _____

Address _____ City _____ Zone _____ State _____

(Continued from page 46A)

column neon lamp, hot cathode lamps, color of neon lamps.

6. The Low-voltage Mercury Fluorescent Tubular Lamp — fluorescent materials, rare gas and mercury fillings, control equipment and circuits, dimming, high frequency operation, direct current operation, effect of voltage variations, ultra-violet emission, flicker and stroboscopic effect.

7. Cold-cathode Fluorescent Lamps — technical data and circuits.

8. Medium-pressure and High-pressure Discharge Lamps — spectral emission, construction, electrical and lighting characteristics.

9. Recent Applications of the Rare Gases to Lamp Manufacture — the gas arc (argon, krypton and xenon), flash tubes.

10. Principles of Illumination — fundamental concepts, units, photometry, lumen method of calculation.

11. Colour — chromaticity diagram and trichromatic coefficients, tristimulus values, color names.

Although this volume deals specifically only with British lamps, it presents the basic theory underlying the production of light and operation of each specific type of lamp and, therefore, will be of considerable value to American lighting engineers. The material presented is highly technical, but there is sufficient explanation that it should be understandable to anyone seeking detailed knowledge on lamp operation.

***The Science of Color** — by the Committee on Colorimetry of the Optical Society of America, published by Thomas Y. Crowell Co., New York, 1953. 398 6⅞ x 9¾ inch pages. 127 illustrations. Price, $7.00.

Official book of the Colorimetry Committee is written by 23 leading men and women in the color field. During the twenty years that it has been in preparation a number of sections of it were published by the Optical Society and have been widely used. Although the book is designed to be of value to the scientist dealing with colorimetry, it is directed also toward the reader with a casual interest in color. Concepts on the relationship of light and vision are clarified and the physical laws relating to light are presented.

The first two chapters are introductory, describing how man has used color through the ages and the modern concept of color upon which the science is based. Subsequent chapters are entitled: Anatomy and Physiology of Color Vision, Sensory Aspects of Color, Perceptual and Affective Aspects of Color, Radiant Energy and its Measurement, Psycho-

physics of Color, Quantitative Data and Methods for Colorimetry, and Colorimeters and Color Standards. Over 600 references are cited. A combination glossary and index occupies 23 pages.

Colour in Factory and Office is a set of fourteen data sheets published by the Department of Labour and National Service, Commonwealth of Australia, "to furnish management and its technical advisors with conveniently accessible data on the effective use of interior colour to provide good visual conditions and an agreeable working environment." The data sheets are available from the Department of Labour and National Service, Industrial Welfare Division, Century Building, 129 Swanston Street, Melbourne, C.1 Australia. Price: 3/6 (85c approx.)

RLM Standards Specifications, 1953 edition, contains three officially-approved new specifications for semi-direct industrial fluorescent lighting units and clarifications of existing specifications including new tables of typical coefficients of utilization and light distribution curves. Copies may be obtained from the RLM Standards Institute, 326 W. Madison, Chicago 6, Ill.

STILL AVAILABLE

PREPRINTS OF 1953 I.E.S. NATIONAL TECHNICAL CONFERENCE PAPERS

A limited number of complete sets of the preprints of papers presented at the 1953 I.E.S. National Technical Conference are still available from Headquarters. Members and readers of ILLUMINATING ENGINEERING who have been unable to attend the Conference in person or who wish additional copies of these papers should use the coupon below to order them.

These Conference papers present all that is new in theory and techniques of lighting and are an invaluable reference source.

Order yours now.

Price per set of 27 papers . . . $2.50, including mailing. Just fill in coupon, attach check and mail to I.E.S. Publications Office.

PUBLICATIONS OFFICE
ILLUMINATING ENGINEERING SOCIETY
1860 Broadway, New York 23, N. Y.

Send _____ set(s) 1953 Nat'l Technical Conference Preprints at $2.50 per set, including mailing, to:

Name _____

Address _____

☐ Check (M.O.) enclosed ☐ Bill me

the P&K Story at Newark Airport

Installed by Lightning Electric Service Company of Newark. Consists of 16 Double and 16 Single Tapered Elliptical Arm type poles with 25 foot mounting heights, TB-2 Transformer Bases and 12 foot arms, four 20 foot floodlight poles with Twin Projector Assemblies.

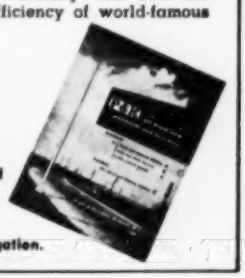
Newark Airport, celebrating its twenty-fifth anniversary this year, has become synonymous with commercial aviation. Today, it covers 2,300 acres in Essex and Union Counties, New Jersey . . . ten minutes from the heart of Newark and twenty-five from mid-town Manhattan. It is truly an important part of the center of world air transport.

Recent extensive modernization conducted by The Port Of New York Authority has made the Newark Airport unsurpassed in every facility that contributes to convenience and efficiency in the handling of all types of civil air traffic.

Pfaff & Kendall considers it a privilege to have been selected to help in Newark Airport's modernization. The P & K All-Aluminum Standards and Brackets, in their clean, functional design, are in perfect harmony with both the new dress and new efficiency of world-famous Newark Airport.

P & K Pfaff & Kendall
84 Foundry Street
Newark 5, New Jersey

WRITE FOR LATEST P & K CATALOG . . . and use the P & K Planning and Advisory Services without obligation.



New Floodlamps Solve Tough Problems Indoors and Outdoors

MAXIMUM LIGHT OUTPUT • WIDE BEAM

200 to 1000 Watts
St'd. or High Voltage

For High or Low Bays

High light output maintained throughout lamp life. Only simple socket required. No reflectors to clean.

For Wet or Dusty Locations

Hard glass withstands moisture and sudden temperature changes. Inside silver reflector not affected by dirt and corrosive fumes.

For Outdoor Lighting

Permits use of low-cost weatherproof housing, reducing cost, size, and weight of installation. Easy to maintain.

Send for Technical Bulletin 80

RADIANT
HI-FLOOD
Reflector Weatherproof
FLOODLAMPS

RADIANT LAMP CORPORATION
300 Jelliff Avenue Newark 8, N. J.

Manufacturers of Lamps for
PROJECTION • FLOODLIGHT • SPOTLIGHT • MOTION PICTURE PRODUCTION
AERONAUTICAL • SPORTS LIGHTING AND GENERAL SERVICE • RECTIFIER BULBS

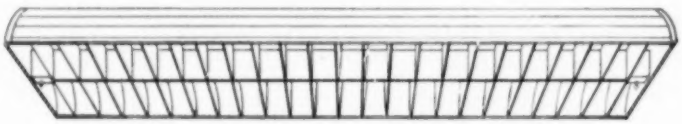
e y e s :

Save pupils' eyes. Save school-lighting dollars. The new MILLER LEXINGTON provides well-shielded overall illumination of high efficiency and low brightness at LOW OVERALL COST. Rigid Quality construction, with long-life finishes. Engineered for quick, easy installation. Low maintenance. Long, dependable life. Write for details.

DESIGN: *Functional—clean, simple lines.*

EASY *2-way lamping—1 ladder position.*

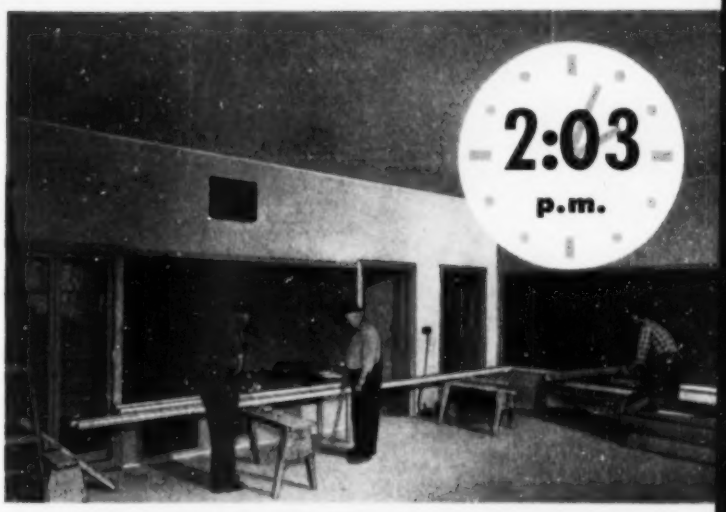
STRENGTH: *Rigid 1-piece steel louver.*



THE **miller** COMPANY, *Meriden, Connecticut*
LEADERS IN LIGHTING SINCE 1844

Lighting Completely Installed

in 85 minutes!



costs cut 27% with UNISTRUT® channel and fittings

New fluorescent lighting was recently installed in 18 classrooms at Lincoln School, Eau Claire, Wisconsin, in record time at a huge savings in cost over conventional methods. "Before and after" photos prove how fast the job was done. In first photo fixtures are just being unpacked at 2:03 p.m. At 3:28 p.m. second photo shows installation of three 24 ft. rows completed, room cleaned, tools and accessories moved to next room for installation there. Total time 85 minutes.

This job* is just one of hundreds where the UNISTRUT system has helped produce the maximum in lighting efficiency while saving installation time and money.

PERFECT ALIGNMENT
UNISTRUT channel is rigid, straight and strong—gives true alignment that servicing can't disturb.

ADDED SAFETY
UNISTRUT installations are safer. Continuous row becomes a single integrated unit—weight is equally distributed along all suspension points.

COMPLETE FLEXIBILITY
UNISTRUT installations are made in spite of ceiling irregularities. Stems can be attached at *any* point along channel.

LOW COST
The UNISTRUT system is quickly, easily erected. Saves costly installation time—permits wiring to be done at working level. Fewer hanger rods are needed. Approved as wireway in Chicago and more than 20 major cities.

It'll pay you to find out how the UNISTRUT system will help solve your lighting installation problem—*faster, better, at lower cost.* Contact your nearest UNISTRUT distributor or dealer today—he's listed in your telephone directory.

*Garden City Plating Company, Chicago, Ill. Fluorescent Fixtures.
E. F. Klingler & Associates, Eau Claire, Wis. Architects and Engineers.
Roshell Electric Service, Chippewa Falls, Wis. Electrical Contractor.

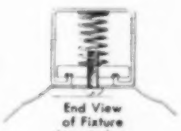
Hanger Fitting P-2335.

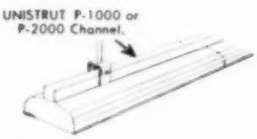
Snap-in Closer Strip.

Joiner Fitting U-940.

Write today for free Fluorescent Lighting Bulletin FF-3

U. S. Patent Numbers
2327587 2329815 2345650
2363382 2380379 2405631
2541908 Other Patents Pending


End View of Fixture Mounted on UNISTRUT Channel.



Catalog in Sweet's 1953 Architectural, Plant Engineering and Industrial Construction Files.

UNISTRUT®
THE WORLD'S MOST FLEXIBLE ALL-PURPOSE METAL FRAMING

UNISTRUT PRODUCTS COMPANY Dept. L9
1013 W. Washington Blvd., Chicago 7, Illinois

Please send Bulletin FF-3, without obligation.

Name _____

Company _____

Address _____

City _____ Zone ____ State _____

INTERNATIONAL RECTIFIER CORPORATION
EL SEGUNDO CALIFORNIA

Selenium Photo-Cells

UNMOUNTED CELLS

6 cell sizes.
15 to 750 microamperes at 100 ft.-candles illumination.

WRITE FOR BULLETIN PC-649

HERMETICALLY SEALED

DP-2 (shown above) 25 microamperes*
DP-3 — 50 microamperes*
DP-5 — 600 microamperes*
*At 100 ft.-candles illumination

INTERNATIONAL RECTIFIER CORPORATION

1521 E. Grand Ave., El Segundo, Calif. Phone: ORegon 8-3778
CHICAGO 205 W. Wacker Drive. Phone: Franklin 2-3889
NEW YORK 501 Madison Avenue. Phone: Plaza 5-8665

Is *YOURS* The Latest?...

You can't be sure you have *all the facts* about lighting unless you have a copy of the new . . .

Second Edition

I.E.S. LIGHTING HANDBOOK 1952

Prepared by I.E.S. technical committees, this 987-page lighting compendium contains 18 sections of lighting practice, theory and calculations . . . Appendices . . . Manufacturers' Reference Data . . . 655 photos, drawings, lighting tables, charts, graphs, to help you solve tough lighting problems.

If your problems are lighting problems, don't be another day without the new I.E.S. LIGHTING HANDBOOK.

Price . . . $8.00

I.E.S. Members: If you have not ordered, your special member copy is only $5.50 now.

ORDER NOW!

Publications Office

ILLUMINATING ENGINEERING SOCIETY
1860 BROADWAY NEW YORK 23, N. Y.

We design and fabricate

ORNAMENTAL LIGHTING FIXTURES

of genuine bronze or wrought iron, for churches, schools, banks, and public buildings, to your order or to architects' specifications. No order too large, none too small. M-W metalcraftsmanship has a nationwide reputation for highest quality.

Write for our new illustrated catalog

MEIERJOHAN-WENGLER
1102 W. 9th St. CINCINNATI 3, OHIO

FOR STANDARD OR CUSTOM BUILT LIGHTING INSTALLATIONS SPECIFY

solux

Manufacturers, Engineers and Designers of Commercial, Institutional and Industrial Lighting for Stores, Offices, Hospitals, Banks, Art Galleries, Schools, Public Buildings and Custom Built Applications ...

- **Fluorescent slimline**
- **Incandescent**
- **Exits and directional signs**
- **Exterior wall lanterns**
- **Hospital-institutional**
- **Custom built luminaries**

for your lighting requirements contact

solux CORPORATION
1338 INWOOD AVENUE · NEW YORK 52 · N.Y.
PHONE: CYpress 3-3434

INDEX TO ADVERTISERS
September 1953

Abolite Lighting Division Jones Metal Products Co.	47A
Acme Electric Corp.	46A
Advance Transformer Co.	30A
Benjamin Electric Mfg. Co.	Back Cover
Certified Ballast Manufacturers	Inside Back Cover
Champion Lamp Works	47A
Corning Glass Works	37A
Curtis Lighting Inc.	4A
Day-Brite Lighting Inc.	33A
Eastern Fixture Co.	36A
Electro Silv-A-King Corp.	12A
Garden City Plating & Mfg. Co.	18A
General Electric Co., Apparatus	38A
General Electric Co., Lamp	44A
Gibson Manufacturing Co.	25A
Edwin F. Guth Co.	45A
Illuminating Engineering Co.	40A
International Rectifier Corp.	52A
Jefferson Electric Co.	26A
Leadlight Fixture Co.	48A
Lighting Products Inc.	29A
Litecontrol Corp.	2A
Luminous Ceilings Inc.	39A
Meierjohan-Wengler	52A
Metalcraft Products Co. Inc.	53A
Miller Co.	50A
Moe Light, Inc.	11A
Pfaff & Kendall	49A
Photo Research Corp.	41A
Pittsburgh Reflector Co.	Inside Front Cover
Radiant Lamp Corp.	50A
Rambusch Decorating Co.	17A
Rohm & Haas Co.	20A
Silvray Lighting Inc.	31A
Smithcraft Lighting Div.	15A
Sola Electric Co.	54A
Solux Corp.	52A
Southern Plastics Inc.	46A
Sunbeam Lighting Co.	34A
Superior Electric Co.	35A
Unistrut Products Co.	51A
F. W. Wakefield Brass Co.	8A-9A
Westinghouse Electric Corp., Lighting	1A, 22A-23A
J. A. Wilson Lighting & Display Inc.	43A

Something **NEW** in **INDUSTRIAL** Lighting!

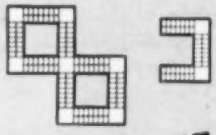
Designed to Meet Latest I.E.S. STANDARDS!

A new two-lamp semi-direct luminaire with 20% uplighting, 86% over-all efficiency! Two-piece construction, easier to install . . . no tools, screws, bolts needed after stems are in position. Bi-pin and slimline, 4 ft., 5 ft., 6 ft., and 8 ft. lengths, in standard and low brightness. Pendant or surface mounted.

Astra-Lite

Amazing VERSATILITY!

Special corner boxes permit almost any geometric arrangement to provide better lighting for all work areas.



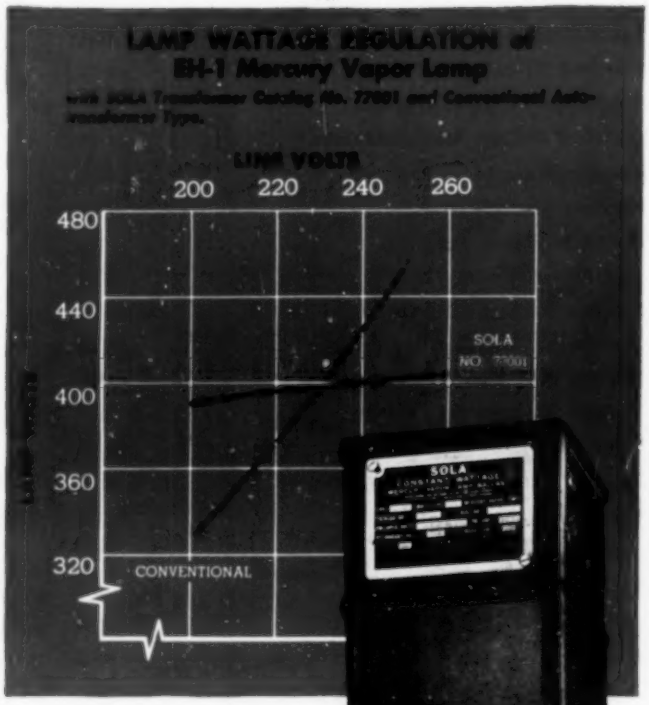
—and it **COSTS LESS!**

Save up to half the cost of conventional industrial luminaires! Write today for brochure and price list!

METALCRAFT PRODUCTS CO., INC.
Manchester & Lippincott Sts., Phila. 33, Pa.
Please send complete data on new Astra-Lite Industrial Luminaires.
Name_____
Address_____
City_____ State_____

extended lamp life

for Mercury Vapor Lamps operating from SOLA Constant Wattage Transformers



INDOOR TYPE CONSTANT WATTAGE UNIT IS ILLUSTRATED HERE.

A direct relationship exists between proper input voltage and mercury vapor lamp efficiency and life. The following facts about this relationship were recently published in leading trade journals:

1. ***Lamp life is shortened through overheating from 5% overvoltage.***
2. ***Mercury vapor lamps extinguish with 15% undervoltage.***
3. ***Light output is cut 15 to 25% with 10% undervoltage.***

Sola Constant Wattage Transformers continuously and automatically supply constant wattage within ±2% regardless of line voltage fluctuations as great as ±15%. This new application of the patented Sola Constant Voltage Principle assures operation of mercury vapor lamps under the same conditions for which they were designed, resulting in:

1. ***Savings of lamp replacement cost, labor expense and inconvenience of relamping.***
2. ***Dependability, since lamps will not extinguish until voltage drops to 75 volts.***
3. ***Maintained light output constant within ±3% even with ±15% voltage fluctuation.***

Regulated Outdoor

Regulated Indoor

Conventional Indoor

SOLA *Mercury Vapor Lamp* **TRANSFORMERS**

Transformers for Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Mercury Vapor Lighting • Luminous Tube Signs
SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois, Estebrook 3-1414 • NEW YORK 20, 153 E. 126th St., TRafalgar 6-6464
PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-6900 • BOSTON: 372 Centre St., Newton 58, Mass., BIgelow 4-3354
CLEVELAND 15, 1836 Euclid Ave., Cherry 1-5400 • KANSAS CITY 2, MO., 406 W. 34th St., Jefferson 4900 • Representatives in Principal Cities

Protect yourself against

1 HIGH REPLACEMENT COSTS

2 HIGH LIGHT COSTS

3 HIGH MAINTENANCE COSTS

CBM CERTIFIED by ETL

Here's why the initials "CBM" on a Fluorescent Ballast are important to you

Q. What do the initials "CBM" stand for?

A. "CBM" stands for CERTIFIED BALLAST MANUFACTURERS. Nine of the country's leading manufacturers of fluorescent ballasts comprise the CBM group.

Q. What does "CERTIFIED" mean?

A. It means that ballasts carrying this diamond-shaped shield have been built to rigid specifications designated by CERTIFIED BALLAST MANUFACTURERS. It means that Electrical Testing Laboratories, Inc., has periodically tested these ballasts and found they meet or exceed the exact specifications designated by CBM.

Q. What's the need for specifications?

A. Ballasts are the heart of fluorescent lighting. CBM specifications make certain the ballasts provide best possible performance for the lamps they operate.

Q. How do CERTIFIED BALLASTS benefit you?

A. When fluorescent lamps do not perform in accordance with published ratings, low quality or improperly designed ballasts may be the cause. However, most lamp manufacturers waive this possibility if the ballasts involved are CERTIFIED.

The CBM Shield is their assurance that the ballast is delivering proper electrical values to their fluorescent lamps.

CBM specifications protect the public interest because they provide:

FULL LAMP LIFE — **RATED LIGHT OUTPUT**
LONG BALLAST LIFE — **FREEDOM FROM OVERHEATING**
QUIET, TROUBLE-FREE OPERATION

Write for complete information on the types of CERTIFIED CBM BALLASTS available from each participating manufacturer.

Participation in the CERTIFIED CBM BALLAST program is open to any manufacturer who complies with the requirements of CERTIFIED BALLAST MANUFACTURERS.

CERTIFIED BALLAST MANUFACTURERS

Makers of Certified Ballasts for Fluorescent Lighting

2116 KEITH BLDG., CLEVELAND 15, OHIO

a step upward in seeing comfort...

BENJAMIN "Task-Master"

FLUORESCENT LIGHTING SYSTEMS

25% upward light
insures a new high in comfortable seeing by eliminating sharp ceiling contrast or harsh shadows

As illuminating engineers know, it is not TOO MUCH LIGHT which causes seeing discomfort. Often the cause is TOO MUCH CONTRAST... distracting contrast between unlighted ceilings and light walls. UPWARD LIGHT is one important way to solve this "brightness ratio" or extreme contrast problem.

The Benjamin "Task-Master" capitalizes fully on the Upward Light principle, by providing a 25% upward flow of light. This means an entirely new concept of lighting unit design . . . all the electrical control equipment is in the ends! All the wiring runs through a unique "spine" support which also doubles as a lamp shield! Thus, the entire body of the unit is left free to produce greater upward light, better quality light, without sacrificing high light output efficiency.

a step forward in easier installation and maintenance

special "hook-up" design speeds installation!
patented "Springlox" lampholders cut maintenance cost!

Typical of "Task-Master's" pace-setting, new installation-and-maintenance methods is the practical "hook-up" design shown here. This patented feature enables the installer to temporarily hang one unit on another while connecting the furnished jumper wires. A boon to continuous-line jobs . . . saves manpower . . . speeds up installation.

"Springlox" is another exclusive Benjamin feature, yours with "Task-Master." These rugged, all-metal lampholders speed up and simplify lamp maintenance. Patented spring design insures against service interruptions due to faulty electrical contact. Self-adjusting action prevents lamps from dropping out or being shaken loose.

Get complete details on all the unique "Task-Master" features by sending for Bulletin AD 5906. It's yours free on request to Benjamin Electric Mfg. Co., Dept. 1, Des Plaines, Ill.

A Product of Benjamin Electric Mfg. Co., makers of famous Benjamin and Leader Line Lighting Equipment and Sound Signals for Industry, Institutions and Commerce.
Sold exclusively through electrical contractors.

TB-262